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100 ktd tailings filtration and beyond

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Abstract

The development of large-scale filters for tailings filtration has advanced significantly, with a concept plant capable of handling capacities of 100 ktd being presented. This plant is designed to meet the evolving needs of the mining industry as it adapts to changing regulations and social pressures. While various methods for tailings storage are acceptable, the Global Industry Standard on Tailings Management *(United Nations Environment Programme et al. 2020) standards encourage solutions that enhance the safety and sustainability of tailings storage. Tailings filtration emerges as an effective solution in this context.*

The concept plant is validated by comparing it to existing references, focusing on the features that need development to achieve a substantial increase in plant capacity. The concept encompasses the entire flow sheet, from thickening to tailings placement. Filtration testing is linked to plant-level scale-up and ancillary equipment selection. Beyond filtration, the plant must be operable and maintainable at a reasonable cost. The technical concept is supported by a financial model that compares capital and operating costs, providing a unified production cost unit for tailings processed.

In addition to the technical and financial aspects, the concept plant also considers environmental and social factors. The implementation of tailings filtration can significantly reduce the environmental footprint of mining operations by minimising the volume of tailings stored in tailings dams. This reduction in tailings volume can lead to decreased risk of dam failures and associated environmental disasters. Furthermore, the adoption of tailings filtration can improve the social license to operate for mining companies, as it demonstrates a commitment to sustainable and responsible mining practices.

Overall, the development of a large-scale tailings filtration plant represents a significant step forward in the mining industry. By addressing technical, financial, environmental, and social considerations, this concept plant offers a comprehensive solution to the challenges of tailings management.

Keywords: *filtration, dry stacking tailings*

1 Introduction

The development of large-scale filters for tailings filtration has advanced significantly, with a concept plant capable of handling capacities of 100 ktd being presented. This plant is designed to meet the evolving needs of the mining industry as it adapts to changing regulations and social pressures. While various methods for tailings storage are acceptable, the *Global Industry Standard on Tailings Management* (GISTM) (United Nations Environment Programme et al. 2020) standards encourage solutions that enhance the safety and sustainability of tailings storage. Tailings filtration emerges as an effective solution in this context.

Tailings management is gradually changing with guidance from the GISTM, although there is ongoing reluctance to embrace new practices. Filtered tailings are becoming more common in gold operations and leached residues where tonnages are lower; however, this approach has not yet seen widespread adoption in the copper industry, which typically deals with larger projects. Some stakeholders express concerns that large-scale tailings filtration may be impractical or cost-prohibitive. Developments in large-scale filter

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technology have aimed to address these issues. While filtered tailings may not become the universal standard, they offer benefits for managing tailings in environmentally sensitive and water-scarce areas.

Pressure filtration has evolved over nearly a century, yet its foundational principles remain relatively unchanged despite numerous technological advancements. Most pressure filters incorporate multiple filter elements positioned between rigid end plates; optimising the number of plates for specific process conditions helps to minimise initial investment costs. The design of filter plates remains a crucial factor, and ongoing development is essential to ensuring reliable and cost-effective operation.

The industry has made substantial investments in developing larger filters, with plate sizes increasing from 2 m to as much as 4 or 5 m and filtration areas surpassing 2,000 m² in recent years. Despite these advances in scale, optimal performance has not been consistently achieved across all large filters, particularly in mine tailing's applications. Filter manufacturers differ in their approaches, with Metso adopting distinct strategies to tailor technologies to the mining industry's needs. Rather than solely focusing on maximising process drivers such as pressure and area, there is a greater emphasis on enhancing both reliability and technical efficiency to address rising capacity requirements for tailings filtration. Evaluating daily throughput may provide a more reliable indication of unit size, as filtration area alone does not necessarily ensure operational effectiveness or efficiency.

Expectations within the mining industry often do not align with advancements in filtration technology. Unlike mills and crushers, where deploying the largest single unit can be advantageous, this approach is less effective for filtration systems due to shorter component lifespans and the operational benefits of utilising multiple units. While it may not be practical to install hundreds of filters in a plant, achieving a target throughput of 100 ktd will require multiple filtration units, optimally determined by maintenance and operational strategies. It is important to recognise that filtration equipment alone cannot address all challenges; instead, solutions should be considered at the system or plant level to ensure overall effectiveness.

2 100 ktd filtration plant concept

To align with the scale and objectives of this evaluation, targeting a large copper concentrator is appropriate. From a strategic perspective, it is essential for the tailings plant to achieve levels of reliability and utilisation that match those of the comminution section, with consideration given to the entire process chain from thickening through to discharge. Validation relies on established references, underscoring key areas for development that can substantially increase plant capacity. As illustrated in the simple view in Figure 1, this concept encompasses all stages, from thickening to tailings transport and placement, with filtration testing guiding plant-scale definitions and the selection of ancillary equipment. Furthermore, the plant must be both operable and maintainable at a reasonable cost, supported by a comprehensive financial model comparing capital and operating expenses to yield a unified production cost per unit of processed tailings. Equipment maintainability and plant safety are paramount in contemporary large-scale filtration facilities. Enhancing safety can be achieved by separating personnel from moving machinery and potential hazards. Given that most filter components are sizable and not suitable for manual handling, safe maintenance necessitates the integration of overhead cranes and access platforms within the filter building design. Ideally, maintenance activities should require only brief equipment stoppages for component replacement, while repairs are conducted separately from active operations. Logistics for replacement modules and consumable parts contribute significantly to plant reliability.

Figure 1 Typical filtration and thickening plant image

2.1 Operating parameters

For the theoretical 100 ktd plant, a set of operating assumptions is required. A mill utilisation of approximately 95% has been selected. This sets the design hourly rate and the boundary for reliability, temporary storage and maintenance.

With the tailings throughput set at 100 ktd tailings, mill capacity is not required; however, a plant of this capacity would likely have a head grade of copper in feed of <0.5% with 30% Cu in concentrate which results in >98% of feed tonnage reports to tailings. The tailings would have a solids specific gravity (SG) of 2.6 to 3 and a primary grind with a $D_{80} \approx 200$ um, D_{50} of 25 um. The ore would be a sulphide resource with low to moderate clays.

Under these conditions, there would be effective thickening achieving >60% solids using high-rate thickening. High-compression thickening could achieve >64% solids, and a median density of 62% solids has been selected.

2.2 Output targets

Dry stack geotechnical targets require a filtered tailings moisture of 15 %w/w. The filtered tailings are assumed to be transported by conveyor to the final deposition area. While minimising freshwater consumption is not a strict requirement, filtration plants are often remote from the main plant and tailings filtration is usually associated with water scarce regions. Consequentially, low freshwater consumption has been set as a requirement in the analysis.

The primary drivers for the filtration plant are defined as filtered cake moisture, plant availability, adaptability to variable feed conditions, and compatibility with downstream materials handling and transport systems.

A review of operating sites suggests that using 10–12 filters aligns with labour utilisation and overall availability requirements. The flow sheet design is significantly influenced by the required reliability to meet the tailings production where a high mineral process plant availability of 95% has been chosen, which allows for tolerance of a single conveyor line outage and provides redundancy in the filter line level to compensate for filter availability which is generally lower than mill availability. Maintenance scheduling is coordinated with the lifespan of the filter cloth and mill reline shutdowns. The plant layout ensures sufficient space is allocated for replacing filter wear parts and offline maintenance of filtration plant components. The design criteria is shown in Table 1.

Table 1 Process design criteria

Item	Units	Value
Annual ore treatment (nominal)	tpa	33,500,000
Nominal tailings	tpd	100,000
Operating schedule		
Tailings to filtration	%	100
Tailings dewatering plant	tpd	100,000
Operating hours per day	h/day	24
Operating days per year	days/a	365
Utilisation	%	92
Design factor	%	100
Filter feed	dry t/h	4,167
Tails thickening		
Thickener underflow solids	%w/w	62
Thickener underflow slurry density	Specific gravity	1.652
Tailings slurry storage		
Total residence time	h	2.00
Tank volume (live)	m^3	2,034
Tailings filtration		
Feed to filter plant	t/h	4,167
filter utilisation	%	82
Required filter availability	%	85
Number of filters	–s	10
Filter feed	t/h	508.13
Filtration rate	kg/m^2h	257
Filter area	m^2	1,977
Filtered cake moisture	%w/w	15
Tailings transport		
Number of conveyors		1
Filter feed (dry)	t/h	4,166.67
Filter feed (wet)	t/h	4,901.96
Maximum belt capacity	t/h	6,500

2.3 Design sensitivity

Tailings thickening depends on the type of mineral being processed, the grinding objectives within the concentrator, and the thickener's residence time. High-rate thickening technology is used, although utilising High-compression thickening could raise feed density to 65–70% solids and potentially increase the filtration rate by up to 10%. Locating tailings thickening near the filtration plant supports the management of filtrate and cloth wash water recycling and helps reduce dilution.

Filterability is influenced by the type of mineral processed and the grinding objectives set within the concentrator. The capacity of filters and the attainable cake moisture may be adversely affected by the presence of swelling clays, a significant proportion of particles below 20 microns, and the specific gravity of the feed material. Filtration rates typically range from 150–350 kg/m^2h; for this analysis, a median value of 257 kg/m^2h has been utilised.

The materials handling is impacted by the design and location of the tailings storage facility and the site topography. These factors impact the distance transported and the span of the bridge stacker. The design capacity is selected for catch-up capacity and moderate utilisation.

The concept plant (Figure 2) is validated by benchmarking against established references, with emphasis on developing features necessary to achieve significant increases in plant capacity. The conceptual design covers the complete flow sheet, from thickening through to tailings placement. Filtration testing informs both plant-scale implementation and the selection of ancillary equipment. In addition to filtration, operability and maintainability at an economical cost are fundamental requirements.

Equipment maintainability and plant safety are paramount considerations in modern large-scale filtration facilities. Enhancing safety can be achieved by effectively separating personnel from moving components and other potential hazards. Due to the considerable size and weight of most filter parts, manual lifting is impractical; thus, the inclusion of overhead cranes and access platforms within the filter building is essential to support safe maintenance activities. Where feasible, equipment should only be shut down for component replacement rather than for component repairs; rotable spares, which for maintenance can be performed away from operational areas, are a preferable approach. Efficient logistics for replacement modules and consumable parts further contribute to maintaining high levels of plant reliability.

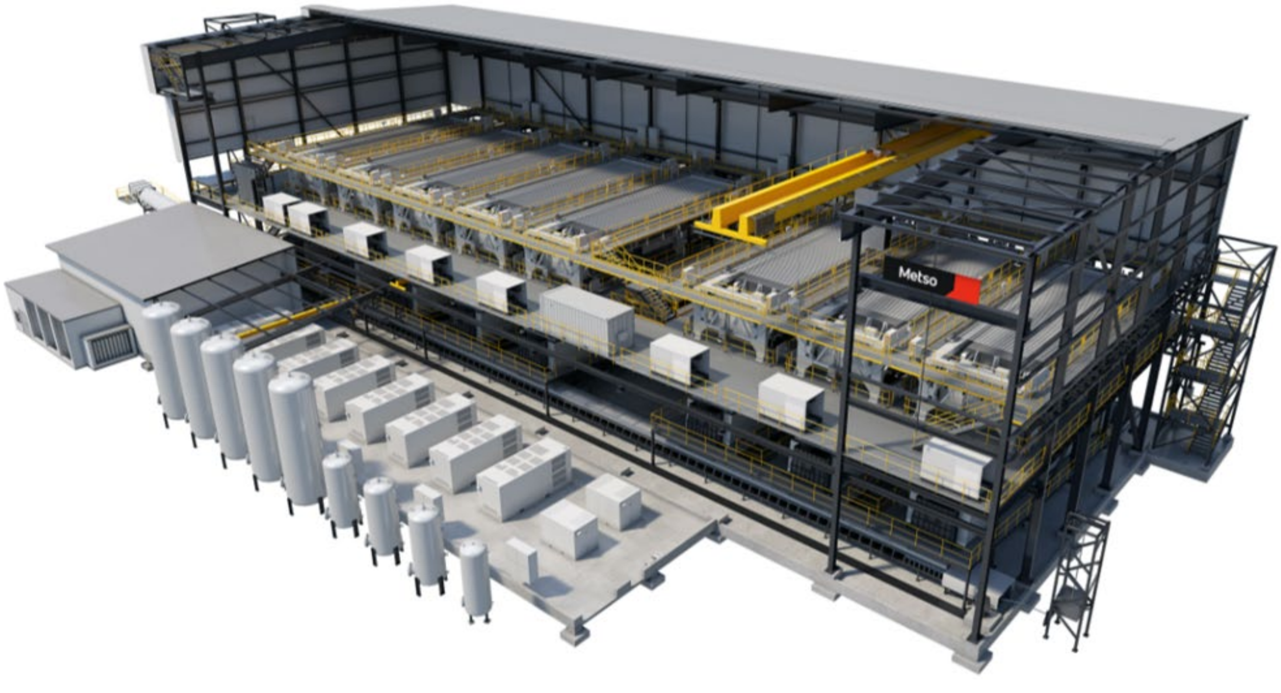

Figure 2 Typical filtration plant

3 Design sensitivity

Mineral concentrators run at full capacity for long stretches, generating tailings continuously. In contrast, pressure filtration works in batches; a filtration system needs to be designed with catch-up and buffering capability to compensate for intermittent operation. The slurry entering the plant flows consistently, requiring the filtration system to be designed for continuous intake. Each filter operates at maximum capacity, determined by the filterability of the tailings rather than overall plant output, with the number of filters selected to meet operational demands. Since filtration and feed capacities may not align exactly, fluctuations in the feed tank level are expected. Filter throughput can be reduced by introducing waiting intervals or increased by deploying additional duty units. In normal operation, this variation need only match the time required to bring a duty unit online. With standby filter lines the plant capacity is not filtration limited.

Considering the conditions that will inhibit the filter plant availability, we need to consider the slurry transfer and materials handling functions where usually we have a single line taking the full plant capacity where an equipment failure can completely shut down the filtration plant. Building redundancy in the slurry handling is relatively straightforward, but with the materials handling being a significant portion of the total system cost, full redundancy in materials handling may not be an option. Where permitted, an emergency tailings storage option that allows bypass of the filtration plant and materials handling in the event of a system failure is an excellent option to maintain plant production.

3.1 Materials handling

Since this is a conceptual plant, there is no defined location to determine terrain or materials handling requirements. Selecting a flat, level site can simplify plant layout considerations. If an appropriate tailings facility is not located near the mineral concentrator, it is advisable to locate the filtration plant close to the tailings facility. Slurry transport to the plant is generally a lower cost than extending the filtered cake transportation distance.

Materials handling challenges are a predominant factor in the overall system design, influencing aspects ranging from the elevation of the filter plant to maintenance strategies, and ultimately impacting project economics.

A well-designed conveyor system for filtered tailings management integrates several key features to ensure operational efficiency and flexibility. The system typically begins with point-to-point transport, transferring material from a fixed start – in this case the filter discharge point – to variable end locations, accommodating changes in the disposal site as stacking progresses.

In the cake collecting and transfer section, to manage the intermittent nature of filter cake production and to handle maintenance schedules, filter discharge buffering is incorporated, allowing for a steady feed to downstream conveyors despite fluctuations in upstream operations. Temporary bypass options provide critical redundancy, enabling material to be redirected or temporarily stored when primary routes are unavailable or during planned maintenance. This reduces the redundancy requirements of the main overland conveying system which helps reduce capital and operating expenses.

In the transport and stacking section, overland conveyors move filtered tailings over long distances to the designated stacking area, which may be relocated as deposition progresses. The overland routes can include both horizontal and vertical curves. Access to the stack may require angles of inclination of up to 15°, depending on material properties and terrain. The stacking system needs to be flexible, able to deposit material at different locations and elevations to meet storage and stability requirements based on site-specific geotechnical considerations. These characteristics support continuous plant operation, reduce downtime, and ensure consistent tailings placement despite changing operational conditions. The system should incorporate electric drives and energy-efficient belts to lower the operating costs associated with belt conveying systems.

While water recovery remains an important consideration, the characteristics of material transport and the properties of cake in the stack at the disposal sites ultimately govern the filtered tailings moisture levels. Pursuing water recoveries that exceed stacking moisture typically requires substantial energy input and is seldom economically viable. Material handling challenges should be acknowledged, as managing the movement of moist solids through chutes is complex. Nevertheless, process requirements are generally determined by geotechnical factors and the identification of optimal stacking moisture.

Filter cake handling is difficult at best with poor flow and high shear stress generally associated with moist filter cakes. Bulk material testing which measures the shear strength to quantify the cohesive strength of the filtered tailings and its resistance to flow is valuable information to design chutes and should be tested at design moisture and at a slightly wetter upset condition. Good general principals include vertical surfaces in transfer chutes and the avoidance of temporary storage in bins or silos, and shear points on conveyors.

When filter tailings stacking systems operate asynchronously with milling practices, maintaining near-constant input rates becomes challenging due to the system's need for frequent maintenance, conveyor relocation, and its limited availability. Therefore, it is necessary to implement buffering, temporary storage, and bypass capabilities in the materials handling system to ensure operational efficiency.

The design capacity exceeds the average operational capacity and, in addition to standard safety factors, it is essential to consider the maximum capacity scenario when all filters are functioning. Furthermore, the discharge from the filters to the main transfer conveyor will be influenced by the sequencing of the filters, resulting in variable loading on the conveyor, even though the average load along the belt remains constant. This variability necessitates ensuring adequate cross-sectional area for the transfer conveyor, especially up to the temporary bypass. Downstream from the temporary storage to the discharge point, the system should be engineered to accommodate catch-up capacity by integrating temporary storage materials into the regular system throughput.

There are relatively few documented instances of filtered tailings being transported to dry stack facilities using bridge stackers at scale. Comparative analysis with in-pit crushing and conveying (IPCC) systems and heap leach stacking systems can offer further insights into reliability. IPCC systems generally operate at a larger scale than filtered tailings systems and involve frequent feed point relocation; while the presence of rocks in the feed adds complexity, these conditions may represent a worst-case scenario. Conveyor systems in IPCC operations typically manage significantly higher tonnages (exceeding 500 ktd) and demonstrate comparable complexity, thereby reinforcing the proof of concept's robustness. Industry reports (Morrison 2017) suggest that IPCC conveyor systems require substantial maintenance and relocation periods; excluding mining and crushing-related downtime, a utilisation rate of approximately 80% aligns with current practices. Prolonged conveyor relocation or major component failures can result in extended downtimes, potentially lasting weeks or months, emphasising the importance of designing systems that allow for temporary truck haulage solutions. The conveying system considered for the analysis could be as shown in Figure 3. This is a simplified form, and the overland section would need to be adapted to the terrain and relative location.

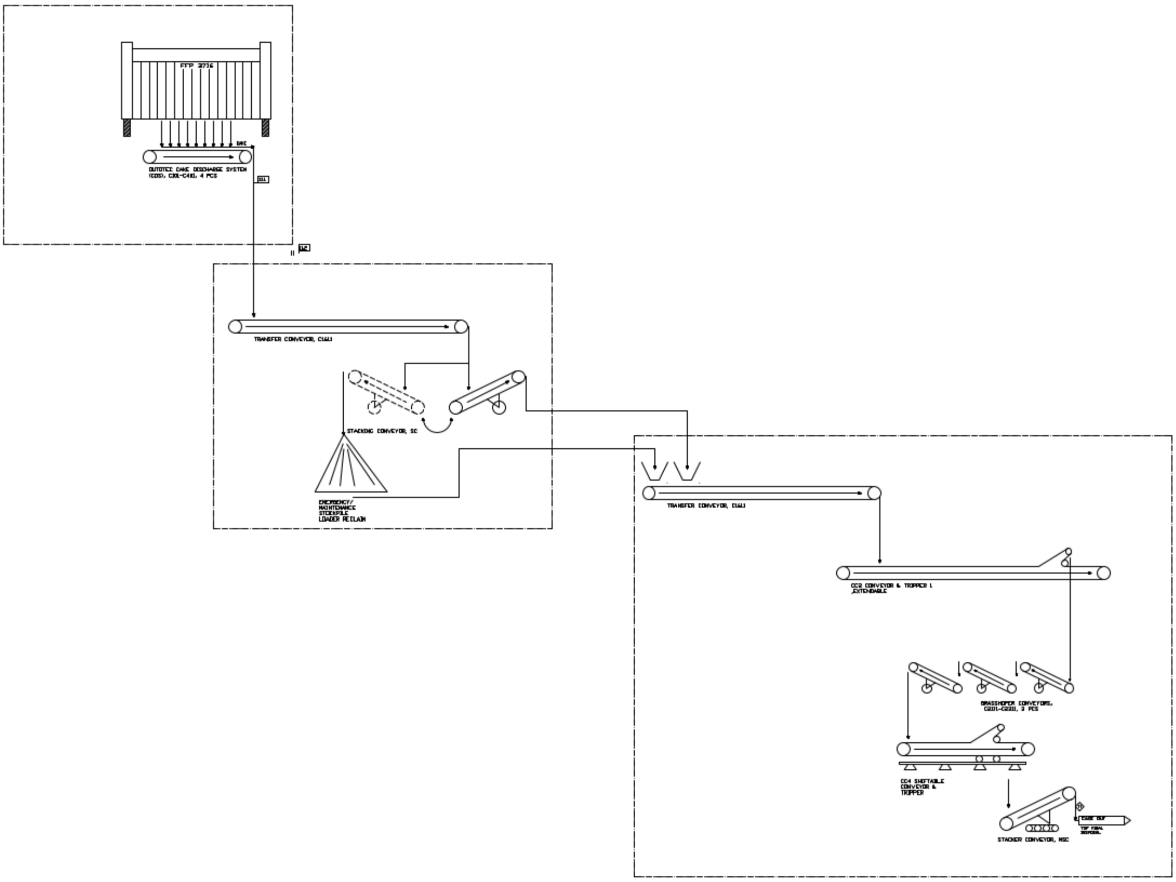

Figure 3 Typical materials handling

4 Case 1 Indian iron ore pellet feed plant

The case study considers several operating sites, each equipped with at least 8 large pressure filters, with a combined production of approximately 4.5 mtpa for each iron ore pellet plant. They provide a reference for effective maintenance and high reliability.

New Delhi based Jindal Steel and Power Ltd (JSPL), benefiting from the huge steel demand in the country, has established itself as one of the leading players in the industry. To meet increasing demand, JSPL was looking for partners to complement their strengths and provide world-class equipment and support to deliver excellent results. To lower energy consumption and to increase plant availability, JSPL decided to install a wet grinding circuit with filtration for its second pellet plant. JSPL awarded Metso a 3-year life cycle services (LCS) contract for the operation and maintenance of e8 Metso VPA filters which has been renewed every year post the completion of the initial 3-year contract. With LCS for filters, JSPL was assured of enhanced availability, higher production and predictive and preventive maintenance to enhance machine life. The VPAs are performing as per JSPL's expectations and are providing significant cost benefits. Under the LCS contract, JSPL and Metso agreed on a clear target; i.e. consistent pressure filters availability of more than 90% which has been delivered ever since (Metso 2020).

Reliable filtration and steady process conditions are important for achieving effective filter performance. Variations in slurry feed can make it difficult to manually keep a filter operating within its ideal range to achieve production targets and desired moisture levels. The Metso advanced control systems identify optimal parameters to improve productivity and energy efficiency by addressing plant-specific challenges. Drawing on experience from numerous process tests and filter installations, optimal operating conditions and suitable filter cloths can be recommended. Proprietary tools are used to conduct plant trials and identify areas for potential improvement. Additionally, advanced process control (APC) solutions have been developed for thickening and filtration that may increase equipment productivity, enhance product quality, and reduce cycle times and energy use. Global installations have reported up to 30% improvements in filtration plant capacity after applying Metso APC solutions for dewatering plants. Thickener and filter optimisers help mitigate upstream process variations, offer enhanced process control, and limit manual intervention requirements.

High filtration performance, limited time for maintenance, and cost pressures require a comprehensive maintenance strategy. Often, preventive maintenance activities focus on major areas like the filter plates and cloths, with less consideration for other critical systems in the filter (Metso n.d.). Problems with the filter are not always visible until they become serious, often resulting in expensive damage to the equipment. The larger the filter is, the more time is required to identify and solve the issue. Good maintenance relies on preventive maintenance strategies and condition monitoring to spread the complete maintenance activities across shorter, more manageable events on critical systems, ensuring that all important components and materials are covered. These shorter and efficient service events help reduce the need for longer planned shutdowns throughout the year, allowing for maximum use of the filters.

4.1 Component lifetime

The service life of filter cloths and wearing parts significantly influences overall filter utilisation. The site operations log provides daily records for 8 filters monitored over a 3-month period. During this interval, moisture levels were consistently maintained at 10%, with a standard deviation of 0.1%. Unit capacity remained within the designed specification (±5%). However, capacity typically begins to decrease following extended use of a filter cloth, with an average loss of approximately 3% observed after 3,000 cycles to the end of the effective cloth lifetime. Filter cloths are generally replaced every 4,000–5,000 cycles, in accordance with capacity requirements and to minimise the risk of unexpected failures.

The data from site indicates strong filter availability, with 8 filters operating consistently over a 3-month period. Each filter achieves an average unit capacity, with utilisation in excess of 80%. To maintain optimal performance, filter cloths are routinely replaced on a scheduled basis at around 4,000 cycles, ensuring high availability and minimal disruption to plant operations. This proactive maintenance approach supports both reliability and productivity, as highlighted in the broader context of comprehensive maintenance strategies for filtration systems.

5 Case 2

Case 2 is a senior gold mining case, with sustainable policies and actions. The site is producing up to 10 ktd of tailings with variable mineralogical characteristics from 3 Metso Larox FFP filters. The project was an operational site that transformed from conventional wet tailings dam to dry stack. A bypass of tailings to a paste backfill plant results in variable feed to the plant. The project began with test work and then progressed through the usual project stages. The filtered tailings are transported by conveyor to a temporary stockpile adjacent to the tailings dam where they are transported by truck, spread and compacted (data extracted from Hamelehle et al. [2021], Laporte et al. [2024] and Pitre et al. [2022]).

Since implementation, there has been a steady decrease in cake moisture, and capacity has varied around the design capacity depending on the ore treated and tonnage sent to backfill. Cloth lifetimes, as shown in Figure 4, are currently 4,300 cycles and there have been minimal wearing parts failures. The graph gives good insight into the effects of cloth blinding and of cloth condition over time and the effectiveness of the cloth washing system. While there is a significant variation in the filterability of the tailings, as indicated by the average filter capacity in the plot, the cloths show minimal effects of cloth blinding as indicated by the difference in capacity between the 3 filters. This difference shows that the filter capacity declines slightly over the cloth lifetimes; over the measurement period, there was less than 2% difference in capacity between filters with differing cloth lifetimes.

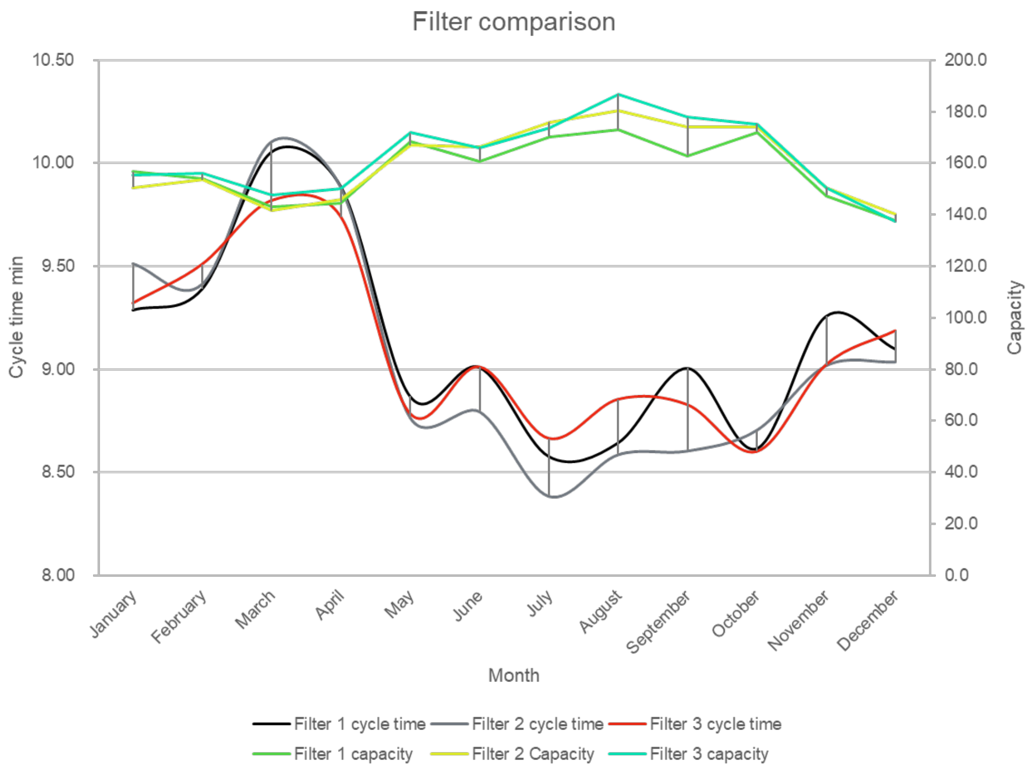

Figure 4 Capacity and cycle time

6 Case 3

Information on the site has been extracted from Amoah (2017, 2024), Amoah et al. (2018) and Dressel (2021). Their research examines the characteristics of filtered tailings and the management of a dry stack storage facility. They emphasise the importance of effective design and operation, based on extensive geotechnical testing, including Atterberg limits, Proctor compaction tests, soil characterisation, and strength and compressibility evaluations using direct shear, triaxial, and Rowe cell methods. In addition, field cone penetration tests to full depth and annual pore pressure measurements have consistently demonstrated negative porewater pressures, supporting evidence of stack stability. There are few references of operating dry stack facilities at significant scale with conveyor cake transport across the world and with only this site operating above 30,000 t/day; although, there are several references of large nickel high pressure acid leach, residue filtration facilities that utilise truck transportation and some studies are considering filtered tailings capacities above 100,000 t/day.

The filtered tailings are stored in a radial pattern called sweeps from overland and bridge stack conveyors. The tailings operation is managed by a 3rd party under a contract agreement with the mine owner. Details of the tailings production, conveying and stacking processes are discussed in Amoah (2017). The site operates 14 large Metso Larox FFP pressure filters on concentrate and tailings duties with high availability since 2012, giving confidence to the number of filters selected for the analysis.

The filters are located side-by-side operating as a line from slurry feed pumping to cake discharge. The building is generous, with adequate area for maintenance, and includes overhead cranes for filter maintenance. Operational contingency is provided by a temporary tailings dam and temporary cake storage.

The materials handling and system design represents an effective system; each filter discharges onto a feeder that buffers the cake discharge. The filtered tailings and coarse rejects from the rougher circuit are collected onto a single overland conveyor that discharges to a radial stacking conveyor that either continues to the stack feed conveyor or discharges to a temporary stockpile. The material is then transferred via a series of conveyors and trippers to a bridge stacking conveyor before discharging to the stack. Learnings from the site are incorporated into the plant design.

7 Cost evaluation

A construction cost estimation has not been reported as there is a significant variation in construction costs depending on plant location, quality of build and scope of installation. It is expected that a filtration plant could be 4 times the equipment cost. Materials handling equipment and construction costs are expected to be greater than the cost of filtration systems, and site preparation for the disposal area will be significant. All estimates are derived from the internal database. Please note that costs are based on tailings discharge via conveyor systems; water, earthmoving and tailings facility costs are excluded from these estimates. Costs for filtration plant equipment have been estimated with an accuracy of ±30% for all equipment filters, pumps compressors and conveyors required for the 100 ktd plant concepts. A summary of opex is shown in Figure 5.

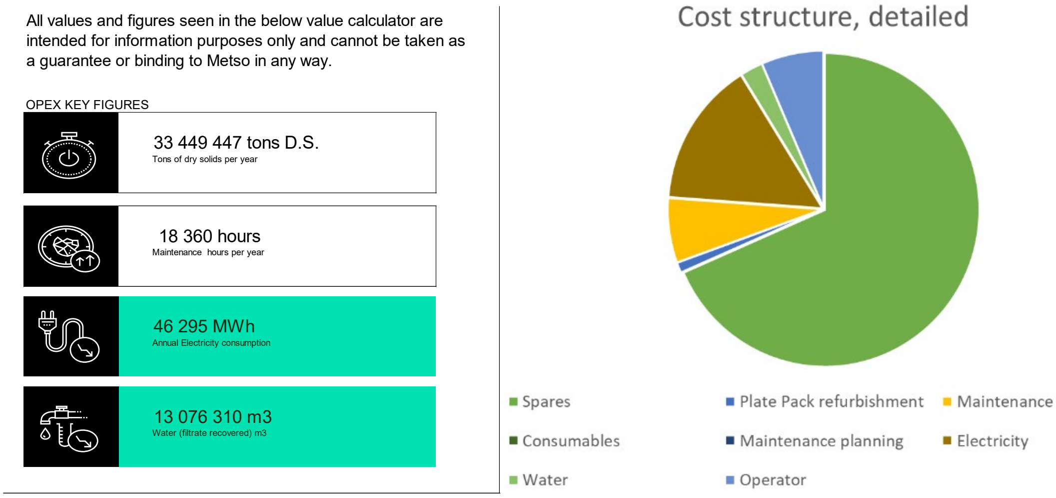

Figure 5 Operating cost

Operating expenses for the filtration plant reflect the projected annual operational costs in EUR (2025) for the proposed conceptual arrangement, incorporating a confidence margin of ±30%. Previous costs reported by Hahn & Dobler (2025) showed opex costs of 0.96 EUR/t for pressure filtration. These are somewhat exaggerated as they predict very high energy consumption and cloth costs inconsistent with our models. Kaswalder et al. (2018) reports opex of pressure filters of 0.68 USD/t at 10 ktd scale.

Material handling costs are expected to be more than EUR 100,000,000, depending significantly on the distance of transport, redundancy and final discharge/stacking methodology. The operation and maintenance of large IPCC conveyor systems is well established, with operating cost estimates reported by Morrison (2017) indicating that cake transportation is likely to add 0.4 EUR/t in opex. Consideration for truck transportation of a portion of the tailings should be added.

Construction of the tailings facility itself and supporting infrastructure will be significant and possibly exceed the cost of filtration and conveying. As with most tailings facilities, these costs can be confused between capital and operating as they are often distributed over a number of years.

Dewatering costs are significantly influenced by the scale of operations, filtration rates, and the lifespan of consumables. For comparable filtration plants, costs have ranged between EUR 0.5 and EUR 5, while tailings transport costs can vary even more widely, with truck transport generally incurring substantially higher expenses.

8 Conclusion

This paper was prepared to address the concerns of tailings filtration at a large scale, and the conceptual evaluation of a large-scale tailings filtration plant designed to handle throughputs of up to 100 ktd, addressing the technical, operational, and economic challenges associated with filtered tailings at this scale. The analysis has focused on conveyor-based transport of filtered tailings and has intentionally excluded costs associated with water supply, earthworks, and tailings storage facility construction, recognising that these elements are highly site specific and project dependent.

The evaluation demonstrates that achieving reliable operation at this scale requires a system level approach rather than optimisation of filtration equipment in isolation. Key design drivers include plant availability, filter utilisation, cake moisture targets, and integration with downstream materials handling systems. Benchmarking against existing large-scale installations confirms that the use of multiple filtration units, supported by appropriate redundancy, maintenance strategies, and buffering capacity, is essential to meeting continuous tailings production requirements. The limitations of small-scale filtration test work are highlighted, particularly in relation to scale-up, clay sensitivity, and the prediction of large filter performance, reinforcing the need for variability testing and conservative design margins.

Beyond filtration performance, materials handling and tailings placement are shown to be critical determinants of overall system reliability and cost. While conveyor-based transport of filtered tailings at large scale remains relatively uncommon, experience from comparable bulk materials handling systems demonstrates that such arrangements are technically feasible when appropriate allowance is made for redundancy, maintenance access, and temporary bypass options.

Each case study was selected to support some of the key challenges in tailings filtration. Each in its own way is a successful plant, although none contained all of the features required to demonstrate 100 ktd plant performance.

The cost evaluation proved difficult to achieve with that level of engineering detail and time available. Many components need specific designs, and a generic approach was inadequate to achieve an accuracy suitable for publication. The costs are heavily dependent on materials handling and tailings facility portions, and while filtration is a significant opex input, its influence on capital is less significant.

Acknowledgement

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