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A case study showing the reduction of capex and opex by filtering fine and coarse fractions separately

Jurgen Hahn [a,*], Timo Dobler [a]

[a] *BOKELA GmbH, Germany*

Abstract

The treatment of tailings is becoming an increasing focus of discussions and decision-making about mining operations. Safety hazards, environmental risks, the huge consumption of fresh water and the cost of mine closure are the main topics discussed. And most, if not all, of the problems could be reduced if the tailings were dry stacked and most of the water was returned to the process. However, this solution requires a significant investment in combination with increased operation costs. The return on investment will come later, with less fresh water being required and far less costs for mine closure.

In many cases the tailings dewatering is studied by comparing different technologies for the total tailings stream. Coal and metal ore processing already show how the processing efficiency can be improved if the total plant feed is split into two or three different size fractions and processed separately. This paper will show how capex and opex can be reduced if the same is done with copper tailings using hydrocyclones to split the tailings into coarse and a fine fractions. For the fine fraction, filter presses are used to ensure the target moisture is reached by applying high pressure. The coarse fraction is filtered on high-performance vacuum disc filters, which can be fed directly with the cyclone underflow. This reduces the size of the tailings thickener to the fines fraction only. This paper will present the two flow sheets and the case study will list and compare the items adding up to the total opex and capex for using filter presses only versus a combination of filter presses and high-performance disc filters. The result is savings of > USD 100,000,000 in capex for copper tailings operations with 100,000–200,000 t/d capacity, plus further savings in opex.

Keywords: *tailings filtration, disc filter, high-performance disc filter, tailings storage facility, backfill, dry stacking, moisture, filter press, capex, opex*

1 Introduction

The treatment of tailings has become increasingly important in mining discussions. Safety hazards, environmental risks and consumption of freshwater are among the main topics under discussion. However, most, if not all, of these issues are reduced if tailings are filtered and stacked in a tailings storage facility (TSF) (Inci et al. 2023). To do this, it is important to dewater the tailings to a moisture level that ensures that liquefaction does not occur on the conveyor belt enroute to the TSF. In addition, the moisture must be low enough to meet all geotechnical requirements for stable and safe stacking (McKenna 2023). The moisture required for this is typically in the range of 13–17% w/w, with an average of 15% w/w. This is a moisture that can be reached with filter presses in most cases. However, the filtration of the tailings with filter presses is quite often the most expensive solution in terms of opex and capex.

Tailings are mostly considered as one flow only. In the processing of coal (Hahn & Elsmore 2023) and many metal ores it is common practice to split the feed flow in two or three fractions with different particle sizes to get a higher separation efficiency. Why not use this method for tailings as well? Peruvian copper tailings are used for this case study. The material was very fine, with 40% w/w less than 10 microns. The target moisture of 15.5% w/w could only be reached with filter presses (Figure 1), which is the most expensive

* Corresponding author. Email address: jhahn@bokela.com

filtration equipment on the market. But what happens if the tailings are split into a fine fraction and a coarse fraction? Does this split allow less expensive filtration equipment such as vacuum disc filters to be used?

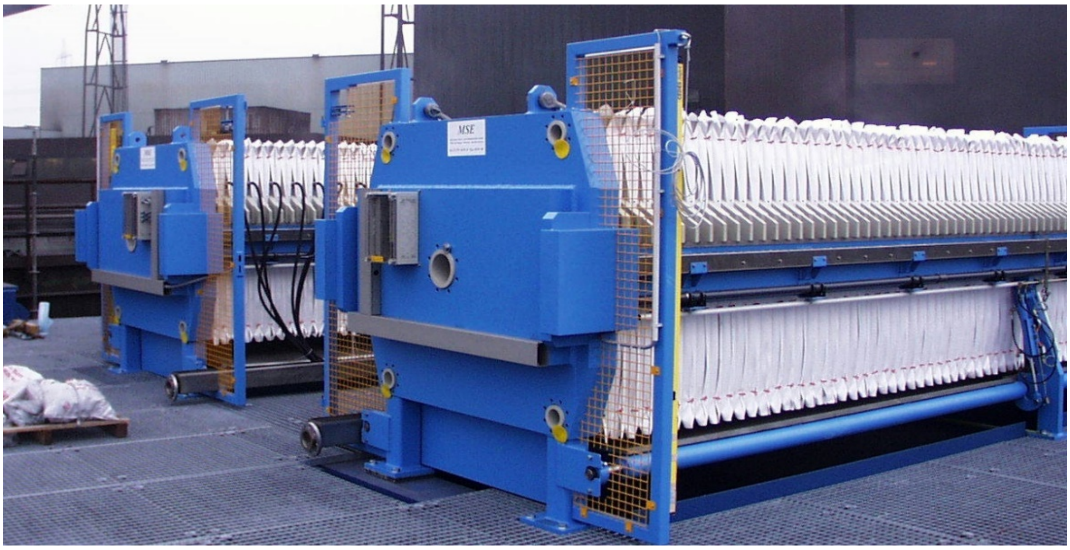


Figure 1 View of a filter press

2 High-performance vacuum disc filters

For tailings filtration in mine backfill applications, the use of vacuum disc filters is common practice. The moisture requirement for mine backfill is in the low- to mid-20s as the tailings are typically mixed with cement and are hydraulically placed. The majority of mine backfill applications are < 10,000 t/d solids throughput and therefore there is still room for standard vacuum disc filters as well as other vacuum filter types.

The situation changes if TSF with 100,000–200,000 t/d or above are targeted. Then filters with high solids throughput and moisture < 20% w/w are required. Modern vacuum disc filters called 'high-performance vacuum disc filters', as shown in Figure 2, are becoming an alternative to filter presses. The following technical description of these high-performance vacuum disc filters and how they differ from standard disc filters was already described in the paper 'How tailings characteristics affect capex and opex in filtration: two case studies' (Hahn 2024). However, it is important to repeat this chapter to understand why these high-performance vacuum disc filters can compete with filter presses.

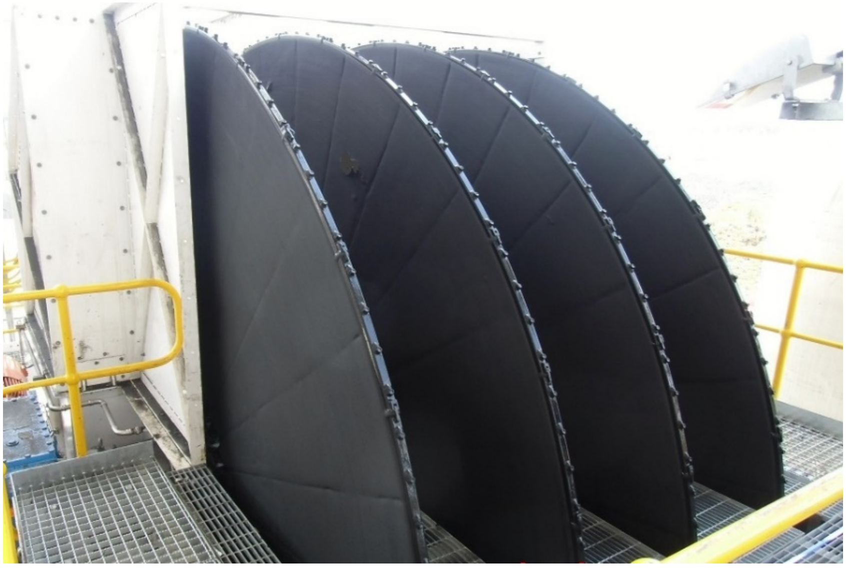


Figure 2 A high-performance vacuum disc filter

High-performance vacuum disc filters are designed for maximum solids throughput, which is why they can operate with slurry levels in the filter trough/bath of up to 50%, as shown in Figure 3. At this high slurry level in the filter trough/bath, half of the filtration area is submerged in the slurry and can be used for cake formation while the other half remains for cake drying (Hahn 2023).

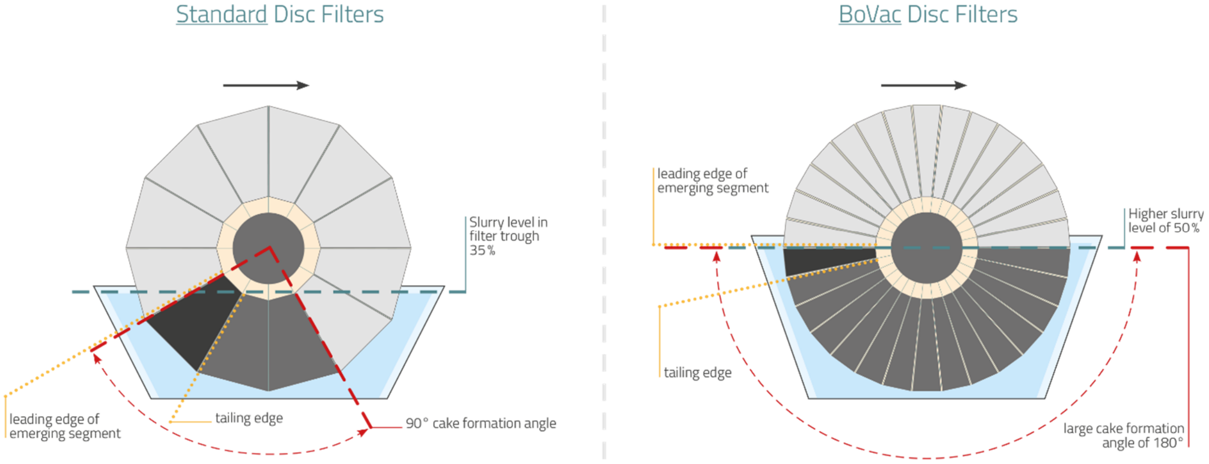


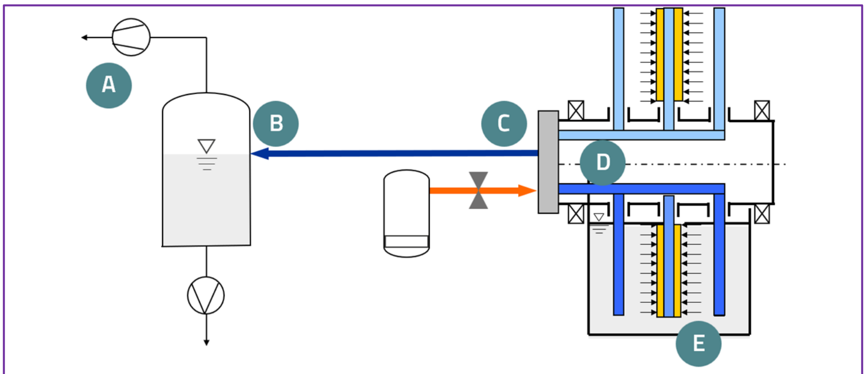
Figure 3 Slurry level and cake formation angle for a standard disc filter and a high-performance disc filter (BoVac)

Furthermore, high-performance vacuum disc filters are designed to minimise pressure losses by using:

- trapezoidal filtrate pipes (more cross-section area = less flow velocity)
- pre-separation control heads (minimising two-phase flow which creates high pressure losses)
- high perforated filter segments (minimum pressure loss for liquid and air to pass)
- online cloth wash (reduces cloth blinding and thus minimises pressure loss in the filter cloth).

Trapezoidal pipes allow for up to three times the cross-section area compared to circular pipes. This reduces the flow velocity, which is important because the pressure loss increases with the square of the flow velocity. Thus the triple cross-section area means a third of velocity and a ninth of pressure loss, compared to that of circular pipes.

The pre-separation control head separates about 90% of liquid and air already. This is important because a two-phase flow can generate up to 10 times a pressure loss compared to a single-phase flow. The real impact of these design features on the reduction of pressure losses can be seen in Figure 4.



Vacuum at	A Vacuum pump	B Receiver inlet	C Control head	D Segment outlet	E Filter cloth
Standard disc	-80 kPA	-70 ... -75 kPA	-55 ... -65 kPA	-45 ... -55 kPA	-30 ... -50 kPA
HPDF Tech	-80 kPa	-78 ... -79 kPa	-74 ... -78 kPa	-70 ... -76 kPa	-65 ... -75 kPa

Figure 4 Pressure drop on standard disc filters and on high-performance vacuum disc filters

While both filter types are connected to a standard vacuum pump creating a pressure difference of –80 kPa, the standard disc filter gives a pressure difference of only –30 to –50 kPa at the filter cake. The rest is lost due to pressure losses in the filter system. With the above listed design features, the high-performance vacuum disc filter minimises the pressure loses and still gets –65 to –75 kPa at the filter cake. And this has a major impact on cake moisture. Figure 5 shows the moisture of a tailings sample filtered at different vacuum levels.

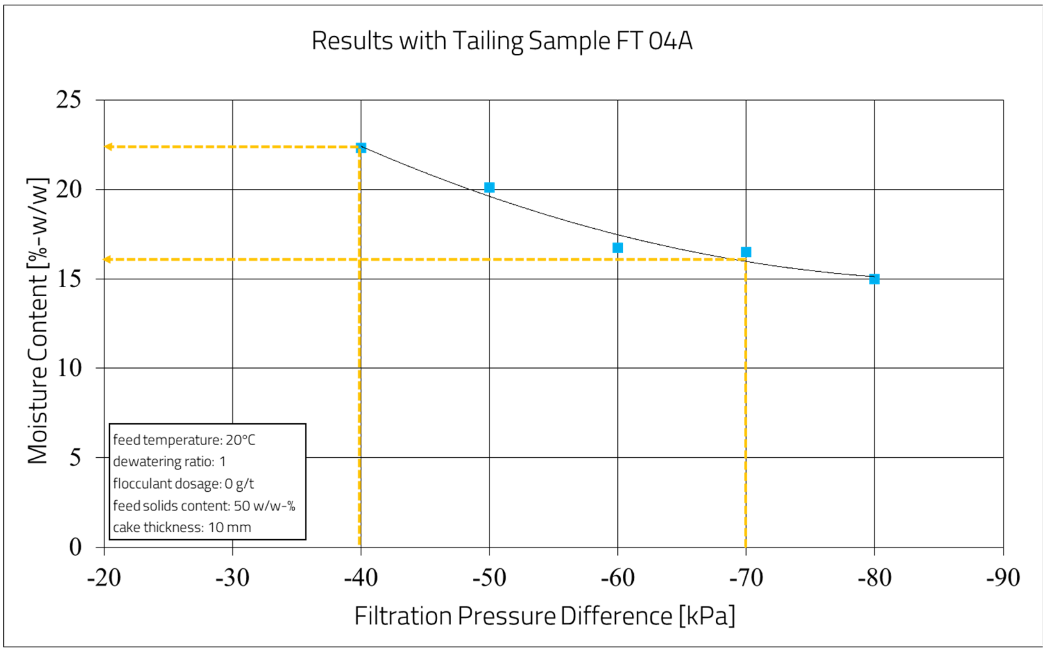


Figure 5 Moisture versus active pressure difference at the filter cake

Due to the pressure losses indicated above, the acting pressure difference at the filter cake of a standard vacuum disc filter is about –40 kPa, which correlates with moisture of 22.5% w/w. Due to the reduced pressure losses of the high-performance vacuum disc filters, about –70 kPa pressure difference is reached at the cake and thus the moisture is 16.5% w/w. This is 6% w/w points less moisture than the standard design disc filters. Therefore, it is recommended to consider high-performance vacuum disc filters as an option for tailings filtration for dry stacking.

Besides the reduction in moisture, the high-performance design with reduced pressure losses results in a high solids throughput as well. The solids throughput of a rotational filter can be determined using the following equation (Bott 1985):

$$M_s = m_s \cdot A_f = \rho_s (1-\varepsilon) \cdot \sqrt{\frac{2}{\eta_L r_C}} \cdot \sqrt{\kappa} \cdot \sqrt{\Delta p} \sqrt{\frac{n}{60}} \cdot \sqrt{\frac{\alpha_1}{360°}} \cdot A_f \cdot 3{,}600 \tag{1}$$

where:

- M_s = solids throughput of the filter (on dry solids basis) in kg/h
- m_s = specific solids throughput (on dry solids basis) per 1 m² filtration area in kg/m²/h
- A_f = filtration area of the filter in m²
- ρ_s = specific gravity of the solids in the slurry in kg/m³
- ε = porosity of the filter cake in vol/vol
- η_L = dynamic viscosity of the liquid in the slurry in kg/m/s
- r_C = relative resistance of the filter cake in 1/m²

κ = solids content coefficient defined as $k = c_v / (1–\varepsilon -c_v)$

c_v = %volume/volume of the solids in the slurry

Δp = filtration pressure difference at the filter cake in $kg/m/s^2$

n = rotational speed of the filter in 1/min

α_1 = cake formation angle in degrees.

Table 1 highlights the parameters to be used in the above equation for both disc filter types.

Table 1 Differences between a standard vacuum disc filter and a high-performance disc filter

	Unit	Standard disc filter	High-performance disc filter
Maximum cake formation angle	°	90	180
Pressure difference at the cake	kPa	40	70
Typical rotational speed range	rpm	0.5–1.0	1.0–2.5

With a given maximum cake formation angle of 90° and a typical pressure difference of –40 kPa at the cake, the standard disc filter reaches its maximum solids throughput at its maximum rotational speed of 1.0 rpm. This solids throughput is now considered as 100% for comparison with the high-performance design. According to filtration theory, the pressure difference at the filter cake, the rotational speed of the filter and the cake formation angle all increase the solids throughput in relation to their square root. If the figures of Table 1 for the high-performance vacuum disc filter design are used, the maximum solids throughput of the high-performance vacuum disc filter design will be 296% compared to the 100% of the standard vacuum disc filter design as shown in Figure 6. In other words, a project needs only a third of the filtration area if high-performance vacuum disc filters are used instead of standard vacuum disc filters.

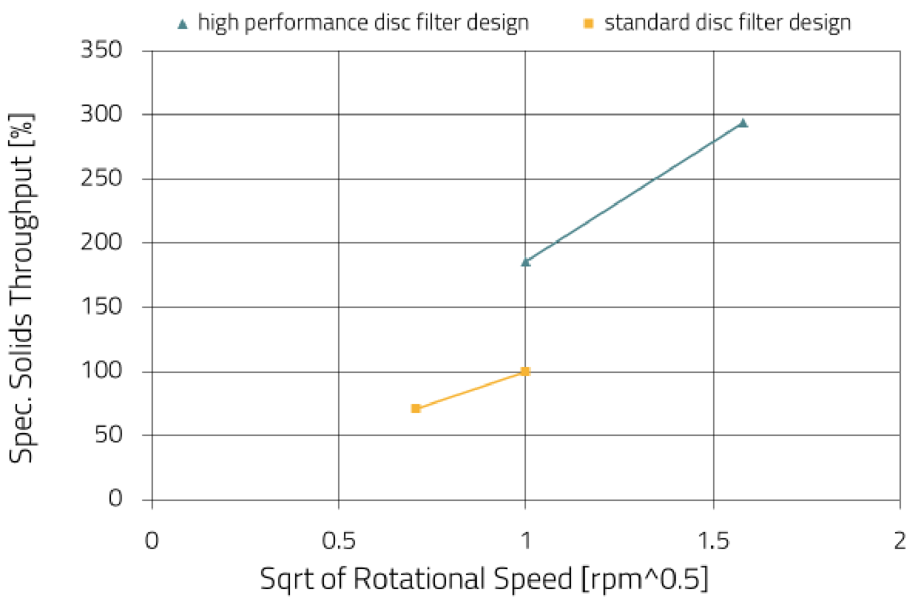


Figure 6 Specific solids throughput m_s versus rotational speed

These high-performance vacuum disc filters are available with sizes up to 352 m² filtration area now. With the moisture improvements and solids throughput increase shown, they are challenging filter presses for the filtration of tailings to be deposited on TSFs.

3 Case study

The treatment of tailings becomes increasingly important if the metal content in the ore is low and if the demand for, and the production of, concentrate is high. Both conditions are common in copper mining and processing in South America. A case study of one of these projects in the Peruvian Andes already provided opex and capex figures (Hahn 2024) for a production of 100,000 t/d of tailings. The review of the project doubled the total production from 100,000 to 200,000 t/d of tailings. The tailings became slightly finer with an increase of the portion < 10 microns from 35 to 38% w/w, and the moisture target was relaxed from 15 to 15.5% w/w, as shown in Table 2.

Table 2 Data of tailings of two mega tailings projects in South America

	Unit	2023/2024	2024/2025
Total tailings	t/d	100,000	200,000
Particles < 10 micron	% w/w	35	38
Target moisture	% w/w	15.0	15.5
Plant elevation	masl	1,000	1,000
Ambient pressure	kPa	89	89

3.1 Using filter presses only

The filtration data of this project for both high-performance vacuum disc filters (Hahn 2024) and filter presses (Mantovani 2023) are listed in Table 3. The largest units available on the market are used for the comparison. While the filter presses benefit from the high pressure and the huge filtration area, the high-performance vacuum disc filters benefit from the short cycle time and generate a much thinner cake that can be safely discharged during continuous operation (Kern & Stahl 1986), with cake thickness down to 7 mm and even 5 mm in some cases.

Table 3 Performance data for a high-performance disc filter and filter press for 200,000 t/d tailings filtration

	Unit	High-performance disc filter	Filter press
Total solids throughput	t/d	200,000	200,000
Total filtration area of filter	m²	352	2,800
Solids throughput per filter	t/d	3,275	8,370
Number of filters in operation	–	62	24
Number of filters installed	–	68	28
Energy requirement per filter	kW	310	750
Total energy requirement per year	MWh/y	168,367	157,680
Flocculant dosage	g/t	0	0
Moisture	% w/w	19.5	14.5

Since the moisture target is 15.5% w/w, only filter presses can be used to achieve this. The opex of the filter presses for 200,000 t/d is listed in Table 4.

Table 4 Opex, if only filter presses are used

	Unit	Large filter presses
Total solids throughput	t/d	200,000
Number of filters in operation	–	24
Energy		
Energy requirement per filter	kW	750
Total energy requirement per year	MWh/y	157,680
Total energy cost per year (EUR 0.2 per kWh)	**EUR/y**	**31,536,000**
Filter aid		
Flocculant dosage	g/t	0
Total filter aid cost per year	**EUR/y**	**0**
Consumables		
Number of cloth changes per year	–	8
Quantity of cloths per filter	–	560
Cost per filter cloth	EUR	300
Cost per filter per year	EUR	1,344,000
Total cost of cloths per year	**EUR/y**	**32,256,000**
Spare parts		
Cost per filter with auxiliaries	EUR	260,000
Total cost of spares per year	**EUR/y**	**6,240,000**
Total opex	**EUR/y**	**70,032,000**

The two major factors for the total opex are the filter cloths and the energy. The cost for energy was calculated with a price of EUR 0.20/kWh. The total opex of the tailings filtration is EUR 70 million, which is EUR 0.96/t.

The capex calculated is listed in Table 5.

Table 5 Capex, if only filter presses are used

	Unit	Large filter presses
Total solids throughput	t/d	200,000
Total filtration area per filter	m²	2,800
Number of filters in operation	–	24
Number of filters installed	–	27
Cost per filter including auxiliaries	EUR/unit	13,000,000
Total equipment cost	**EUR**	**351,000,000**

3.2 Splitting the tailings in a coarse and a fine fraction

The tailings are now split at the laboratory scale into a fines fraction and a coarse fraction, with the particle size distribution as shown in Figure 7.

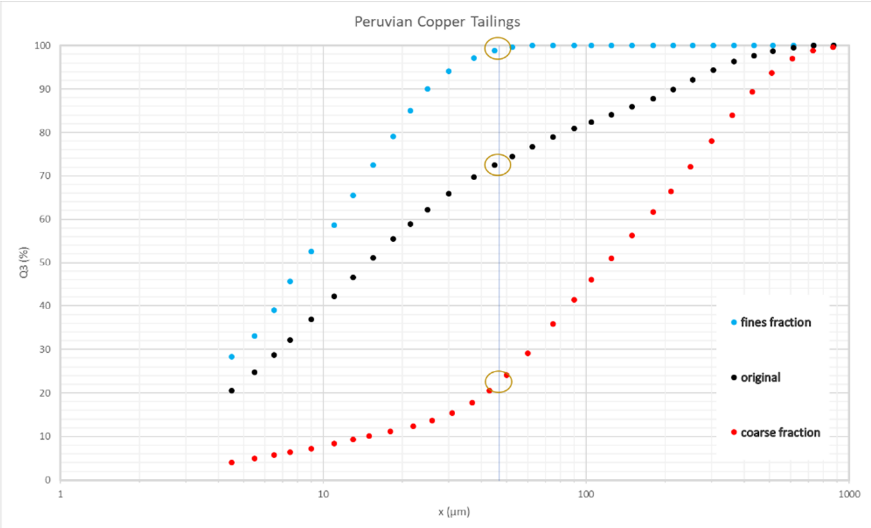


Figure 7 Particle size distribution

The coarse fraction has a medium particle size of 115 micron and the fine fraction has a medium particle size of 8.5 microns. The coarse fraction is 35% of the total tailings mass and the fines fraction is 65%. Both fractions are now filtered at the laboratory scale with different filter types. The fines fraction has been thickened to a solids content of 60% w/w, which is a bit lower than the 64% w/w of the thickener U/F solids with the original tailings flow. This may require a slightly higher floc dosage to the thickener which was not investigated further during the tests. And this fines fraction is still filtered with filter presses. However, because of more fine solids in the feed flow and the reduced solids content in the feed to the filter presses, the total solids throughput per unit is reduced by about 20% compared to the solids throughput of the original tailings and the moisture increased from 14.5 to 15.0% w/w. The coarse fraction is filtered on high-performance vacuum disc filters reaching a moisture of 14.5% w/w. The filtration performance figures are summarised in Table 6.

Table 6 Performance of coarse and fines fractions filtered on different filter types

	Unit	High-performance disc filter	Filter press
Total tailings solids throughput	t/d	200,000	200,000
Total solids throughput per filter type	t/d	70,000	130,000
Total filtration area per filter	m^2	176	2,800
Solids throughput per filter	t/d	21,590	6,700
Number of filters in operation	–	4	20
Number of filters installed	–	5	22
Energy requirement per filter	kW	1,100	750
Flocculant dosage	g/t	7.5	0
Moisture	% w/w	14.5	15.0

Each BoVac Disc L176 high-performance disc filter reached a solids throughput of 900 t/h at a rotational speed of 3.0–4.0 rpm which is 21,590 t/d coarse tailings. Now the mix of the coarse and fine fraction after filtration is reaching a moisture of 14.8% w/w which is well below the moisture target of 15.5% w/w. This is a viable option for the project now. What does this mean for opex and capex?

The opex calculation is listed in Table 7.

Table 7 Opex, if the coarse and the fines fraction are filtered on different filter types

	Unit	HP disc filter	filter presses	Total
Total solids throughput of this type	t/d	70,000	130,000	200,000
Number of filters in operation	–	4	20	
Energy				
Energy requirement per filter	kW	1,100	750	
Total energy requirement per year	MWh/y	38,544	131,400	
Total energy cost per year	**EUR/y**	**7,708,800**	**26,280,000**	**33,988,800**
Filter aid				
Flocculant dosage	g/t	7.5	0	
Total filter aid cost per year	**EUR/y**	**574,875**	**0**	**574,875**
Consumables				
Number of cloth changes per year	–	6	8	
Quantity of cloths per filter	–	120	560	
Cost per filter cloth	EUR	40	300	
Cost per filter per year	EUR	28,800	1,344,000	
Total cost of cloths per year	**EUR/y**	**115,200**	**26,880,000**	**26,995,200**
Spare parts				
Cost per filter with auxiliaries	EUR	30,000	260,000	
Total cost of spares per year	**EUR/y**	**120,000**	**5,200,000**	**5,320,000**
Total opex	**EUR/y**	**8,518,875**	**58,360,000**	**66,878,875**

The total opex of EUR 66,878,875 is a 4.5% reduction compared with the exclusive use of filter presses only as listed in Table 4. This may not be enough to justify the use of two different filtration technologies plus the extra equipment for splitting the tailings. But how is the capex comparison? The capex is calculated and listed in Table 8.

Table 8 Capex, if the coarse and the fines fraction are filtered on different filter types

	Unit	HP disc filter	Filter presses	Total
Total solids throughput	t/d	70,000	130,000	200,000
Total filtration area per filter	m^2	176	2,800	
Number of filters in operation	–	4	20	
Number of filters installed	–	5	22	
Cost per filter incl. auxiliaries	EUR	1,500,000	13,000,000	
Total equipment cost	**EUR**	**7,500,000**	**286,000,000**	**293,500,000**

The split of the tailings in a coarse and a fines fraction require feed tanks, a set of hydrocyclones and the feeding pumps. This is adding a few million EUR which is not considered in the above comparison as it is expected to be < 2% of the total CAPEX.

The high-performance vacuum disc filters are operating continuously and drop the cake with a moisture of 14.5% w/w directly on the main conveyor system. The filter presses already have the equalizer and the individual conveyors. At that stage it is expected to have enough mixing of fines and coarse when simultaneously dropping the filter cakes on the main conveyor. Therefore, no extra capital cost is considered for mixing.

The split of the tailings in combination with the use of different filter types reduces the capex by almost 20% or a total of almost EUR 60 million for the 200,000 t/d operation. In combination with the roughly EUR 3 million annual savings in opex makes this option quire attractive in comparison to using filter presses only.

The above case study shows that the reduction of number of filter presses required, immediately reduces the capex in a quite substantial way. Therefore, it is worthwhile to look for further opportunities to treat more of the tailings on high-performance disc filters.

3.3 Splitting the tailings in a fines fraction and a mix of coarse and fines

Now, only 75% w/w of the original tailings are split into 1/3 to be coarse (25% of the original tailings) and 2/3 to be fines (50% of the original tailings). 25% of the original tailings remain as they are. Now the fines in the overflow (OF) of the hydrocyclones are still going to the fines thickener. But it is only 75% of the total tailings flow which reduces the capital cost for the thickener, the feed tanks, pumps and cyclones. The thickener underflow (UF) is fed to the filter presses with about 60% solids, and again this may require a slightly higher amount of flocculant which is not considered in the opex calculation below but should be < EUR 1.0 million per year. The remaining 25% of the original tailings and the coarse fraction (hydrocyclone UF without thickening) are mixed and filtered on high-performance vacuum disc filters, with the performance figures summarized in Table 9.

Table 9 Performance of fines and a mix of coarse and original tailings

	Unit	High-performance disc filter	Filter press
Total solids throughput	t/d	200,000	200,000
Total solids throughput per filter type	t/d	100,000	100,000
Total filtration area per filter	m²	352	2,800
Solids throughput per filter	t/d	6,140	6,700
Number of filters installed	–	17	15
Number of filters installed	–	19	17
Energy requirement per filter	kW	350	750
Flocculant dosage	g/t	5.0	0
Moisture	% w/w	16.0	15.0

The BoVac Disc XL352 high-performance disc filters run at a speed of about 1 rpm, get a cake thickness of around 8 mm (typical cake thickness for this filter type) and reach a solids throughput of 256 t/h, which is 6,144 t/d. Because of the addition of original feed with fine particles, the air flow through the filter cake is less, which is the reason for the higher moisture of 16.0% w/w. Furthermore, the vacuum pump size decreases, which, in combination with the reduced solids throughput per filter, reduces the energy requirement per filter in comparison to the operation with the coarse fraction only.

The fines fraction after thickening is still filtered on filter presses. The mix of the filter cakes from both filter systems is reaching a moisture of 15.5% w/w, which is exactly the target moisture. Therefore, this is also a viable option for the project. What does this mean for opex and capex? The opex calculation is listed in Table 10.

Table 10 Opex, if fines and a mix of coarse and original tailings are filtered on different filter types

	Unit	HP disc filter	filter presses	Total
Total solids throughput of this type	t/d	100,000	100,000	200,000
Number of filters in operation	–	17	15	
Energy				
Energy requirement per filter	kW	350	750	
Total energy requirement per year	MWh/y	52,122	98,550	
Total energy cost per year	**EUR/y**	**10,424,400**	**19,710,000**	**30,134,400**
Filter aid				
Flocculant dosage	g/t	5.0	0	
Total filter aid cost per year	**EUR/y**	**547,500**	**0**	**547,500**
Consumables				
Number of cloth changes per year	–	6	8	
Quantity of cloths per filter	–	120	560	
Cost per filter cloth	EUR	50	300	
Cost per filter per year	EUR	54,000	1,344,000	
Total cost of cloths per year	**EUR/y**	**918,000**	**20,160,000**	**21,078,000**
Spare parts				
Cost per filter with auxiliaries	EUR	40,000	260,000	
Total cost of spares per year	**EUR/y**	**680,000**	**3,900,000**	**4,580,000**
Total opex	**EUR/y**	**12,569,900**	**43,770,000**	**56,399,900**

This is almost a 20% reduction of the opex compared to the exclusive use of filter presses only. This is a substantial reduction as it means an annual saving of EUR 13.63 million. However, it does not yet include the opex for the operation of the hydrocyclone stage, which is expected to be in the range of EUR 0.8–1.5 million. The potentially higher amount of flocculant dosage to the fines thickener may add another EUR 1 million. Nevertheless, it is still an overall saving of > EUR 10 million.

The capex calculation is listed in Table 11.

Table 11 Capex, if fines and a mix of coarse and original tailings are filtered on different filter types

	Unit	HP disc filter	Filter presses	Total
Total solids throughput	t/d	100,000	100,000	200,000
Total filtration area per filter	m^2	352	2,800	
Number of filters in operation	–	17	15	
Number of filters installed	–	19	17	
Cost per filter incl. auxiliaries	EUR	2,000,000	13,000,000	
Total equipment cost	**EUR**	**38,000,000**	**221,000,000**	**259,000,000**

The use of hydrocyclones for splitting the tailings into coarse and fines fractions requires feed tanks, a set of hydrocyclones and feeding pumps, but in this case only for 75% of the total tailings flow. However, now two thickener stages are required: one smaller thickener for 25% of the original tailings flow and one bigger one for the hydrocyclone OF with the fines (50% of the total tailings solids). This adds a few million EUR which is not considered in the above comparison, mainly because detailed data is not available and the extra cost is expected to be < 2% of the total capex.

The high-performance vacuum disc filters are operating continuously and drop the cake with a moisture of 16% w/w directly onto the main conveyor system. The filter presses already have the equalizer and the individual conveyors. At this stage it is expected to have had enough mixing of fines and coarse fractions when simultaneously dropping the filter cakes on the main conveyor. Therefore, no extra capital cost is considered for mixing.

The above figures confirm that, if more tailings can be treated on high-performance disc filters, the total cost of investment in, and operation of, filtration equipment will drop. If the fine tailings (50% of the total tailings) are filtered on filter presses and the rest (a mix of coarse tailings and original tailings) is filtered on high-performance disc filters, the capex reduces by about 26% (or a total of EUR 92 million for the 200,000 t/d operation) as shown in Figure 8.

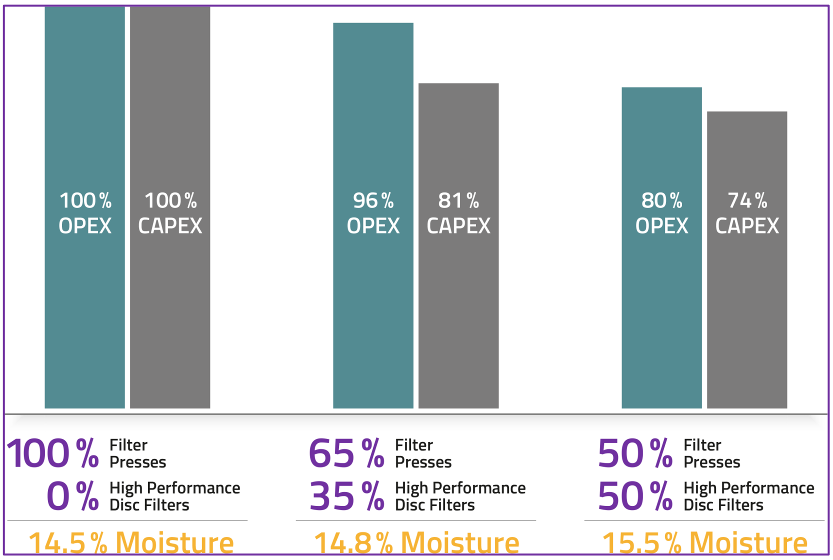


Figure 8 Opex and capex for different combinations of filter presses and high-performance disc filters

So even if the exact figures for the additional pumps, hydrocyclones and extra thickener are available, the total saving will still be > EUR 75 million. In combination with the > EUR 10 million annual savings in opex, it makes this option very attractive in comparison to using filter presses only.

4 Conclusion

The importance of tailings filtration as a means to reduce safety hazards, environmental risks and freshwater consumption will become an increasing factor for the longevity of mining operations and the permitting of new processing plants. But the investment cost, as well as the high operating costs, for tailings filtration remain high, causing owners to think twice about going down the filtration route. However, tailings are mostly considered as one flow only. In the processing of coal and some base metals it is common practice to split the feed flow in two or three fractions with different particle sizes in order to get a higher separation efficiency and a higher yield. Why not using this method for tailings as well? A Peruvian copper tailings was used for the case study. The material was very fine, with 40% w/w to be less than 10 microns. The target moisture of 15.5% w/w could only be reached with filter presses, which is the most expensive filtration equipment on the market. Now the tailings have been split with hydrocyclones into a fines fraction and a coarse fraction. The fines fraction was always filtered on filter presses, getting moisture of 15.0% w/w.

The pure coarse fraction (35% of the original) was filtered on high-performance vacuum disc filters, reaching a moisture of 14.5% w/w. This split requires feed tanks, a set of hydrocyclones and the feeding pumps. The cost for this extra equipment is not yet considered in the capex but is expected to be < 2% of the total cost.

An alternative approach was the split of only 75% of the original tailings, filtering the fines (50% of the original tailings) on filter presses and the mix of coarse (25% of the original tailings) and the remaining 25% of original tailings on high-performance vacuum disc filters to reach a moisture level of 16.0% w/w and a mix moisture of 15.5% w/w, which fulfils the project targets. In this case the split again requires feed tanks, a set of hydrocyclones and the feeding pumps, however, only for 75% of the total tailings flow. An additional thickener for the remaining 25% of the original tailings flow is also required. Again, the cost for this extra equipment is not yet considered in the capex but is expected to be < 2% of the total cost.

In both split cases the high-performance vacuum disc filters are operating continuously and drop the cake directly on the main conveyor system. The filter presses already have the equalizer and the individual conveyors. At this stage it is expected to have enough mixing of fines and coarse when simultaneously dropping the filter cakes on the main conveyor. Therefore, no extra capital cost is considered for mixing. The reduction in opex and capex are represented in Figure 8.

The more high-performance disc filters can be used to reach the moisture target, the more savings in opex and capex are possible. In the given case study for a 200,000 t/d tailings treatment, the reduction of capex can be up to EUR 105 million, in combination with an annual saving in opex of up to EUR 13.6 million. And this is the comparison for a very fine copper tailings with 40% w/w to be less than 10 microns. If the same comparison is done for a coarser copper tailing, the percentage of tailings to be filtered on high-performance disc filters will be more than 50%: thus opex and capex can be reduced even further.

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