Paste 2023 – GW Wilson, NA Beier, DC Sego, AB Fourie & D Reid (eds)

doi:10.36487/ACG_repo/2355_68

Vacuum disc filters go beyond

J Hahn *BOKELA GmbH, Germany*

Abstract

Modern high-performance disc filters such as the BoVac disc filter have set new standards in applications where large capacities of solids, liquids and air must be managed through the filters. These disc filters have an enormous hydraulic capacity. For applications in mineral processing, with a special focus on tailings (which typically have high solids throughputs but low filtrate and air flows), this capacity can be used to expand the filtration area while maintaining the benefits of very good cake discharge, even with thin cakes (4–5 mm) and a high filter speed. Research work over the last century has proven that increasing the filter area should be achieved by increasing the disc diameter because adding more discs leads to big problems with the cake discharge: i.e. the filter cake is not, or is insufficiently, blown off on the filter discs furthest away from the control head. However, as the disc diameter increases, the filter segments become longer and heavier. A suitable compromise was therefore found by doing both. The result is the first vacuum disc filter that offers significantly more than 300 m² of filtration area yet has no more than six discs.

Keywords: *tailings dewatering, vacuum disc filter, backfill, filter area, footprint*

1 Introduction

In the recent past, new filtration challenges have come to the fore. Some solutions aim to achieve low moisture, which is why filter presses or hyperbaric filters are often preferred. The most advanced of these methods is BoHiBar steam pressure filtration (Hahn 2019). Waste treatment, especially tailings filtration, is targeted more for low capex and opex as this part of the processing plant does not generate value. Nevertheless, there is still a moisture target to be reached in order to meet the geomechanical requirements for tailings storage facilities (e.g. dry stacking). But when it comes to mine backfill, the moisture requirements are not a challenge for vacuum disc filters, which are a preferred technology for these applications. They still have to cope with high solids throughputs, but the filtrate and air flows are comparatively low. In particular, modern disc filters are economical solutions with their high performance and extremely low space requirements. Based on the design of modern high-performance disc filters, it is now possible to significantly increase the filter area per unit.

2 Design basis for high-performance disc filters

The BoVac disc filter is a high-performance product whose development is based on three pillars (Hahn & Egger 2017):

- Firstly and fundamentally, the theoretical work and research results carried out in the 1980s and 1990s at the Institute for Mechanical Process Engineering and Mechanics at the University of Karlsruhe.
- Secondly, complementing and deepening this theoretical knowledge by the practical experience BOKELA GmbH has gained from carrying out numerous retrofits of vacuum disc filters worldwide, including at the Gove Alumina Refinery in Australia.
- Finally, the special requirements of the alumina process in terms of extreme pH values, a high tendency to scale, enormous feed streams and solids throughputs had to be taken into account when developing this high-performance disc filter.

These basics and aspects resulted in a new vacuum disc filter design (Figure 1) that is capable of performing with:

- 12–15 $m^3/m^2/h$ feed flow.
- 8–10 $t/m^2/h$ specific solids throughput.
- 8–10 $m^3/m^2/h$ filtrate flow.

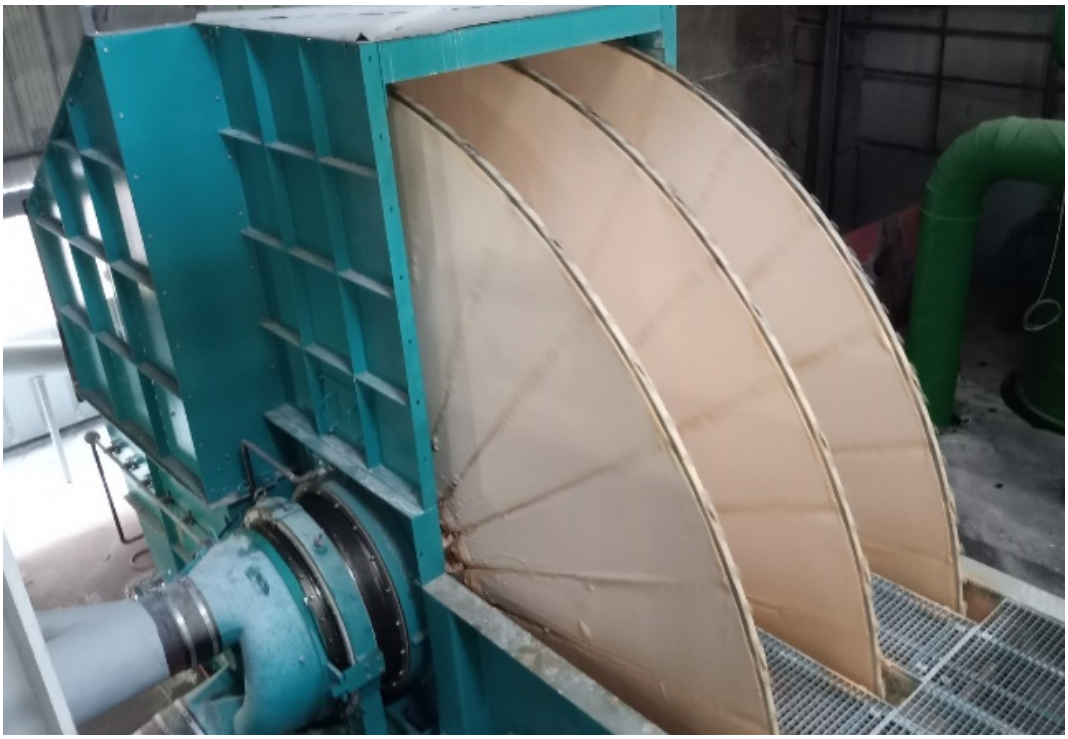


Figure 1 High-performance BoVac L132 disc filter with three discs and a 132 m^2 filter area

3 New challenges for disc filters in tailings filtration

In recent years, tailings treatment projects have become increasingly larger, with solids outputs of 2,000 t/h to 5,000 t/h and even over 10,000 t/h. At the same time, environmental regulations are becoming more and more stringent, which will further advance tailings filtration technology.

In general, tailings are thickened to at least 50 wt% solids content. More common are figures in the range of 60–65 wt% solids content. Vacuum filtration then increases the solids content to levels of 75–85% by weight. This means that the amount of filtrate per 100 t/h of filtered solids is on average 35 m^3/h, with peak values of up to 50 m^3/h. Furthermore, the cake formation on the filter fabrics of all filtration systems is slow because of the following typical tailings characteristics:

- Broad particle size distribution.
- A high percentage (>50 wt%) of small particles <38 µm.
- The clay component of the tailings.

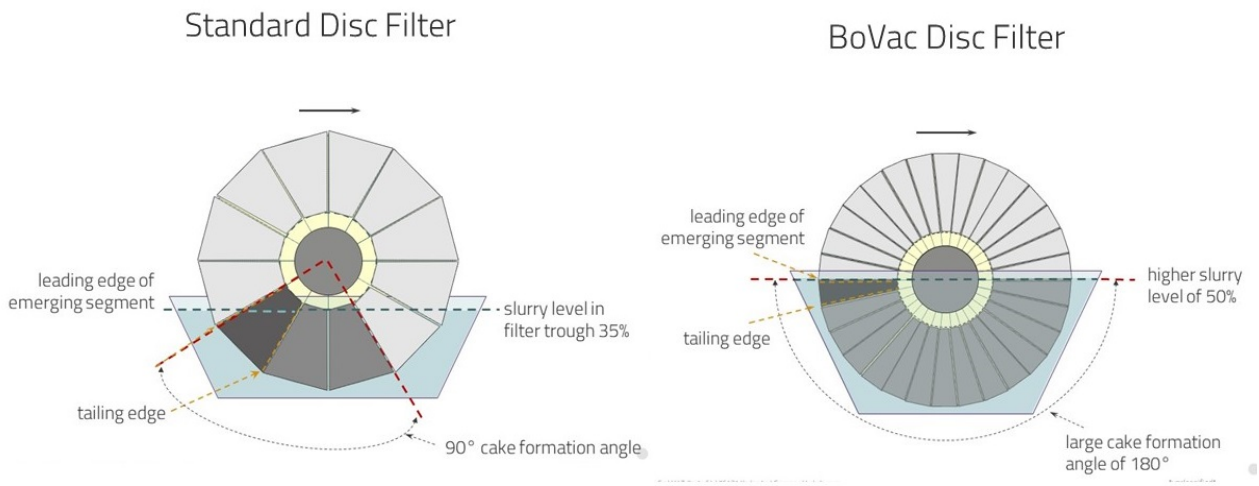
This results in specific solids throughput figures for standard vacuum filters of typically no more than 250–500 $kg/m^2/h$.

4 Differences between standard and high-performance disc filters

High-performance disc filters differ from standard models in crucial points. The main differentiating features of the high-performance filter design are:

- A large number of small filter segments.
- A barrel seal that allows a high slurry level of 50% immersion depth.
- A large cake formation angle of 180° as result of the high slurry level and small segments (Figure 2).
- Minimal pressure loss through a flow-optimised filtrate pipe system.
- A pre-separation control head.
- Effective cake discharge even with thin cakes (4–5 mm) and high filter speeds.

Due to these characteristics, high-performance disc filters such as BoVac's have a significantly higher throughput than standard disc filters. In the filtration of copper, gold and silver tailings (d_{50} = 20–40 µm), the specific solids throughput values of 700–1,500 kg/m²/h are several times higher than the values of standard disc filters. Typical moisture values of these tailings are in the range of 18–22 wt%. For coarser tailings, such as in zinc and iron ore (d_{50} = 50–100 µm), the specific solids throughput can even be up to 2,500–4,000 kg/m²/h. Typical moisture values of these coarse tailings are in the range of 12–18 wt%.



(a) (b)

Figure 2 Slurry level and the cake formation angle of a standard disc filter (a) and the BoVac disc filter (b)

5 New Filter design with enlarged filter area

It was a logical step to use the core components of BoVac's disc filter technology, which is suitable for high filtrate flows and high airflows, to increase the unit size by adding more filter area while still maintaining the benefits of a very good cake discharge, even with thin cakes (4–5 mm) and high filter rotational speed.

BoVac's biggest filter unit, until 2021, offered a maximum filtration area of 176 m^2. The target was to double the filtration area to 350 m² and combine high-performance design with the largest filtration area per unit on the market. The result was the BoVac XL350 (Figure 3), with a 350 m² filtration area on six discs with a disc diameter of 6.4 m. The footprint of this filter is no more than 7.5 × 4.0 m, while including all service areas as well as the filtrate separator and blow air tank increases it to 11 × 10 m (Figure 4). This is more than a 3 m² filtration area per 1 m² footprint.

Major research work in the last century (Kern & Stahl 1984, 1986) proved that while bigger disc diameter can be beneficial, adding more discs will soon result in severe cake discharge issues. Increasing the disc diameter will lead to filter segments becoming longer (>2 m) and heavier (>20 kg). Therefore, a suitable compromise was found by doing both. The result is the first vacuum disc filter providing a 350 m² filtration area while having no more than six discs. Further research work in combination with two-phase flow dynamic calculations have led to further improvements of the filtrate drainage system as well as the cake discharge operation, both of which have patents pending.

When this filter is used for typical tailings applications such as copper, gold and silver etc., a solids throughput of 200–450 t/h is achieved. In most mine backfill applications, this throughput is already more than required. Considering the high availability of the filter of >97%, this means that only one filter is needed for the tailings volume to be handled. As a result, both the size of the backfill plant as well as the capex costs are minimal.

If coarse tailings such as zinc or iron ore have to be filtered, the solids throughput is as high as 800–1,400 t/h. This means that even megaprojects with 10,000 t/h tailings solids do not need more than 8–10 filters in operation.

Figure 3 BoVac disc filter XL350 with 350 m² filtration area

6 Consequences of the new filter design

6.1 Reduced footprint

The footprint of this new generation of vacuum disc filters, including the service area, is only around 110 m². This is only 20–25 % of the footprint of a filter press with the same capacity (Figure 4). Subsequently, the building will only be 20–25 % the size of the building with filter presses, which can result in a significant capex

saving. The price of such a vacuum disc filter amounts to only 20–25 % of the price of a filter press yet it provides the same solids throughput.

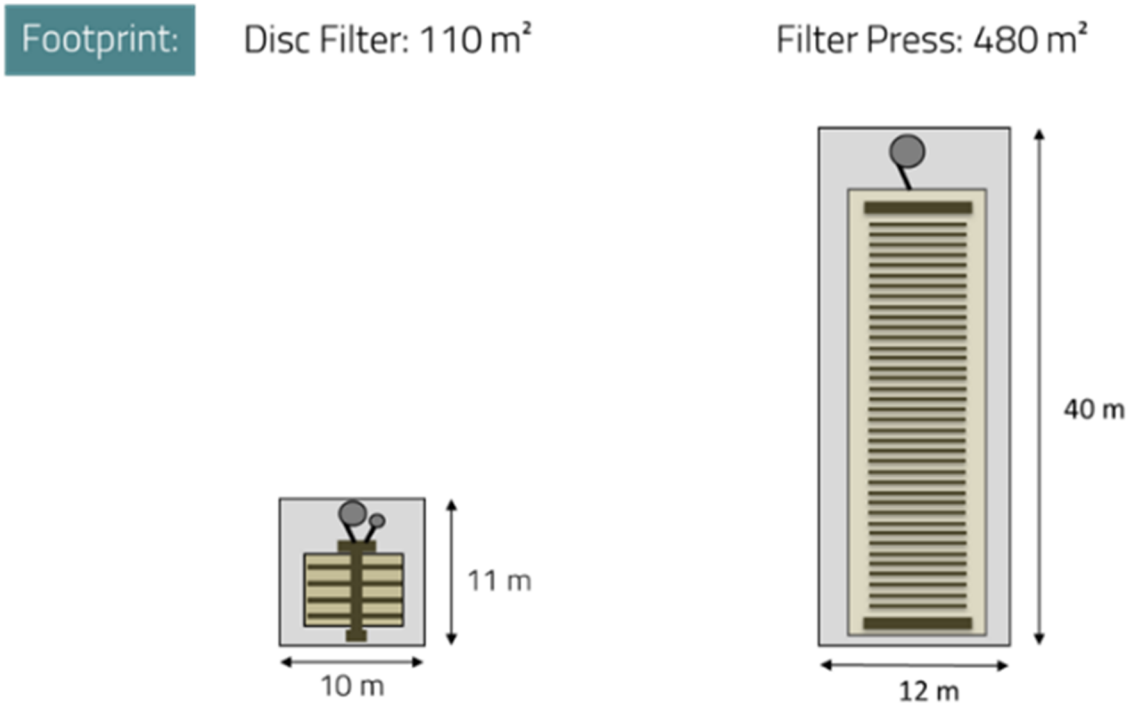


Figure 4 Footprint of a vacuum disc filter and filter press with the same capacity in a tailings filtration application

6.2 Energy demand and opex

Compared to standard disc filters, the BoVac model is operated with reduced specific energy consumption. It requires no more than 25–40 kPa pressure for the air that is used for cake discharge and this air can be generated by the use of a blower. Standard filters, however, mostly require compressed air (100–200 kPa), which has to be generated with compressors at high energy consumption levels.

7 Conclusion

High-performance vacuum disc filters of modern design ensure high throughput and dewatering performance and have excellent operational reliability (even with varying feed conditions). They are the most compact rotary filter type, having by far the smallest footprint, and require very little maintenance.

High-performance disc filters differ from standard disc filters in crucial points. They have an enormous hydraulic capacity and, correspondingly, a significantly higher throughput than standard disc filters. This capacity was used to expand the unit's filtration area and develop a new disc filter with an increased filtration area specifically suited to applications in the minerals industry, particularly tailings applications, which typically process high solids throughputs but have low filtrate and air flows. Based on theoretical knowledge and practical experience in the development and operation of disc filters, as well as in the retrofit of older types of disc filters, the filter area was enlarged by increasing the disc diameter and only moderately increasing the number of filter discs. The result is the first vacuum disc filter that offers 350 m² of filtration area with no more than six discs. The high throughput capacity of this new filter and the small footprint, which is only 20–25% of the footprint of a filter press of the same capacity, allows backfill plants to be run with minimal size, capex and opex.

Acknowledgement

BOKELA GmbH would like to thank its customers for their trust in its technologies and their kind support.

References

Hahn, J & Egger, A 2017, 'Report on tailings dewatering with high performance disc filters', *Proceedings of the 12th International Symposium on Mining with Backfill*, Society for Mining, Metallurgy & Exploration, Englewood.

Hahn, J 2019, 'How far do you have to go – filtration makes the difference', *ICPC 2019 — XIX International Coal Preparation Congress & Expo 2019*.

Kern, R & Stahl, W 1984, 'The discharge of filter cakes', *Proceedings of Symposium Solids/Liquids Separation Practice and the Influence of new Techniques*.

Kern, R & Stahl, W 1986, 'The discharge of filter cake by air blow back: a mathematical simulation to improve design and operation of disc filters', *4th World Filtration Congress*.