Centrifuges: The Alternative Technology

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ABSTRACT

There are several technologies available for thickening and dewatering of mining process slurries.

The most commonly used are thickeners and filters, but technological developments have made centrifuges a viable option and their use, as a modern and alternative technology, is being considered more and more.

In terms of tailings, the main goal for all mine operation is to minimize operating costs and the environmental impact on the disposed material. The high potential risk of wet tailing storage in tailing dams is causing this technology to become unpopular, and there is a strong drive in many parts of the world, by governments, communities and environmental agencies to limit any further construction and use of such facilities.

For the alternative disposal method of dry disposal of tailings, two aspects of the process have to be evaluated, namely the maximum dryness of the separated solids and the maximum liquid recovery. For most mining operation, dry disposal is a new concept. Presenting these companies with examples of operations where this processing option has been successfully applied and proven, will help them to adapt to the changing requirements in the future.

Focus has been placed on adapting decanter centrifuges to the mining environment. Modern decanters stand out in terms of their small footprint, low water demand, high availability and their high degree of automation, combined with the excellent cost / performance ratio. Decanter centrifuges have started to play a key role in applications such as tailing dewatering, drilling and tunneling muds processing, hydrometallurgical processes of gold, nickel or zinc and separating SX crud in copper refineries.

This paper will present advantages of decanter centrifuges compared to the traditional technology and corroborate these advantages by case studies, especially from South America.

INTRODUCTION

The demand for a suitable and cost efficiency dewatering technology is in the focus of several mine operators.

The political and environmental perspective is rapidly changing. There are several technologies established on the market, but there are as well new approaches to the challenges which been faced.

The three most common technologies for dewatering and water recovery are thickeners, press filters and centrifuges.

Several additional factors need to be considered, such as the size of daily operation, whether the mine is an open pit or underground operation, its location, re-use of solids (backfilling), etc.

A general proposal of which technology will take the lead in the future is not feasible.

The following is a short description of each mentioned technology.

THICKENERS

Thickener have been common in mining operation to recover clean water rapidly and continuously, by just using earth gravity ever since the invention of the Dorr Thickener in 1905. These units can be very large with diameters ranging up to 120m.

The solid concentration of the thickener underflow is, however, in the view of most modern mining operation, not sufficient anymore. This has resulted in the development of deep cone or super deep cone thickener to increase the solid concentration of the underflow. Typically, the height of these modern thickeners is equal to their diameter, with a very deep cone at the bottom. The underflow of such thickener supposed to provide solids from the underflow of 55 – 65% by wt. In comparison the average on existing thickener typical not exceed 35 – 45% by wt.

FILTER PRESS

The manufacturer of filter presses have also been adapting to the new challenges, by developing large and more user-friendly operation on their equipment, i.e. full automated rapid discharge cycle, quick washing procedure, etc. At the moment there a several presses in operation, which have plates exceeding 4 x 4 m in size. These presses also try to address the problems of time-consuming solid discharge and washing of the filter cloths have been addressed. The main focus of this technology is to increase the flow capacity which can be handled, since most open pit mining operation are facing severe water challenges with their high demand of capacity increase. Some of the presses are capable of processing > 400 t dry matter an hour, which accumulates to 10.000 t dry matter daily per press.

The use of a thickener of the press filter is mandatory to reduce process volume

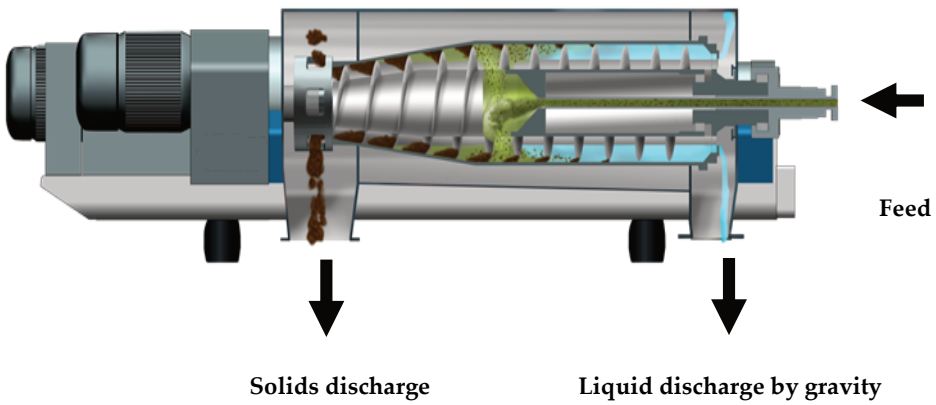
CENTRIFUGES

Centrifuges have been in use for dewatering mainly in municipal wastewater operation where they have gradually replaced belt filters and filter presses almost everywhere. This efficient technology has hardly been used in mineral processing so far. Advantages in the design and modern wear protection makes this product more and more interesting for the mining community.

Centrifuges can work with thickeners, to reduce process volume but at smaller mines or mines that are, integrating a dewatering technology the need of a thickener is not mandatory. Typically, a two-

step process of hydro cyclone and centrifuge will provide almost equal dry matter discharge as a press filter.

Figure 1 Cut-away of solid bowl decanter centrifuge



COMPARISION

The diagram on this page is gives an indication of the parameters that need to be compared to assess the available technologies.

To read the chart correctly, the further the marker is away from center the better the technology rated in this criteria. A perfect solution would be a full coverage of the diagram

The diagram shows a number of parameters that may not be automatically in the mindset of engineering offices or mining companies.

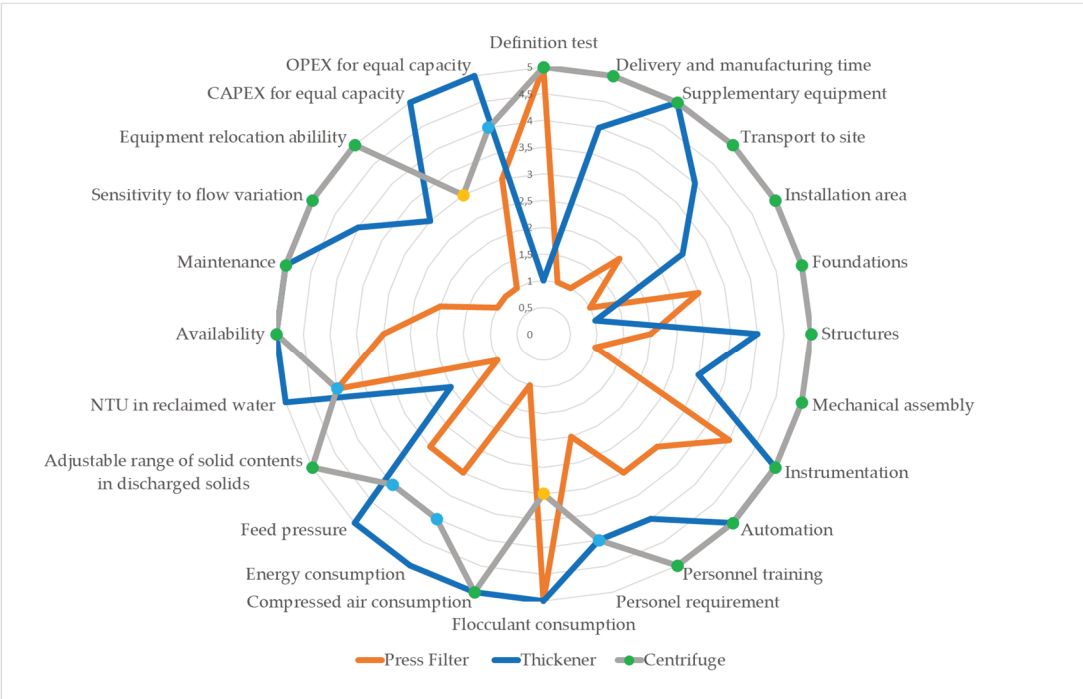


Figure 2 Comparison of the three most common dewatering technologies used in mine operation (Equal volume capacity and equal solid load processing for up to 1.000 t DS/h)

There are two criteria where the centrifuge technology is lacking behind in performance of the other two technologies, namely the consumption of polymer, which in turn has an effect on the OPEX of the equipment.

The type of polymer selected is critical to economic operation of the centrifuge. Unlike the thickeners and filter presses where relatively large, stable flocs are desirable, a centrifuge needs a polymer which reacts very quickly to form very small flocs almost instantly after inline dosing at the centrifuge feed inlet. Due to the short residence time the flocculent only has a maximum of 30 seconds in which to have an effect. To minimize consumption of polymer an online ultrasonic density meter is installed in the feed to optimize polymer dosing.

DEWATERING RESULTS

The dryness of the solids after processing depends strongly on the location as well on the requirement for tailing deposit.

The centrifuge fills the gap between thickened tailings and filtered tailings

Figure 3 Diagram showing the ratio of the solids content of different dewatering technologies. Photos show the typical equipment used for thickening / dewatering

A centrifuge is capable of handling feed variation in wide range but still delivers same high dry matter contents of solid discharge

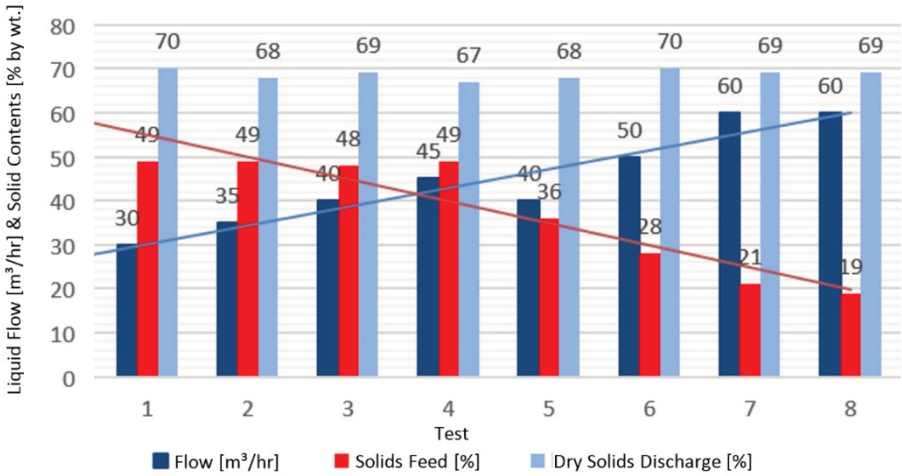


Figure 4 Results of centrifuge dewatering performance with changing feed parameters.

CASE STUDY ARGENTINA

In Patagonia, Argentina, there is an underground gold mine with a capacity of about 2.400 t dry matter per day. The water supply is critical, since no fresh water supply is present. The mine looked for a reliable dewatering technology, which would be able to recover most of the water. The mine operates the dewatering in two processing steps. In the first step, the process water is sent through a set of hydro cyclones to capture larger particles, which will then be mixed with cement to form backfill material for shafts that are no longer in use. The overflow of the hydro cyclones is routed by gravity to an intermediate, agitated tank, from which individual pumps distribute the tailings to the four installed decanter centrifuges. Separated solids collected on a shared belt conveyor installed below all four units. The recovered centrate is then routed to holding tanks, before it is pumped back to the process. In one holding tank, a filter system is installed to provide the centrifuge installation with clean water supply for polymer preparation and flushing capabilities.

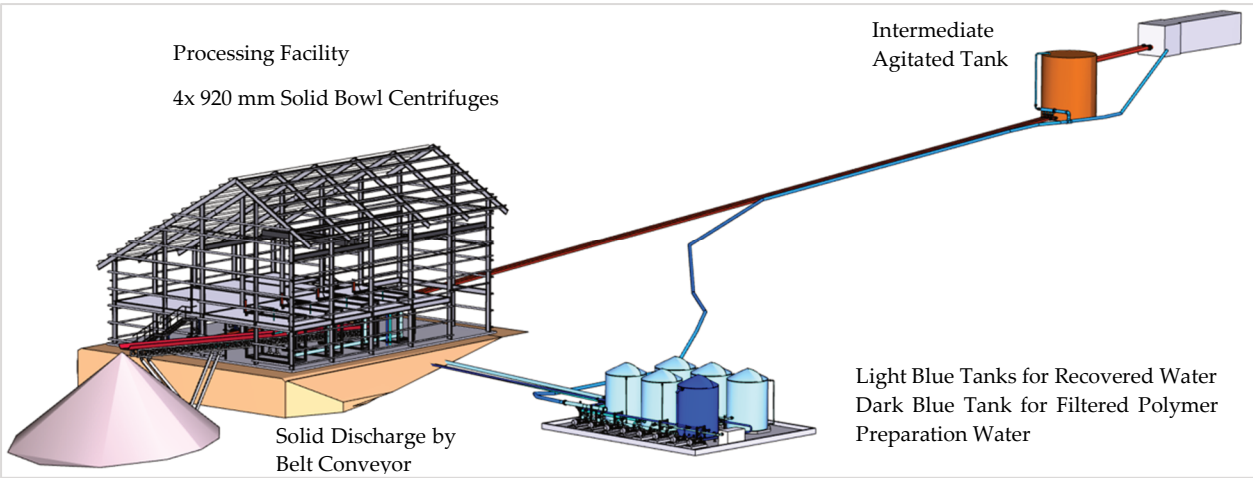


Figure 5 Overall 3D CAD Layout of dewatering facility

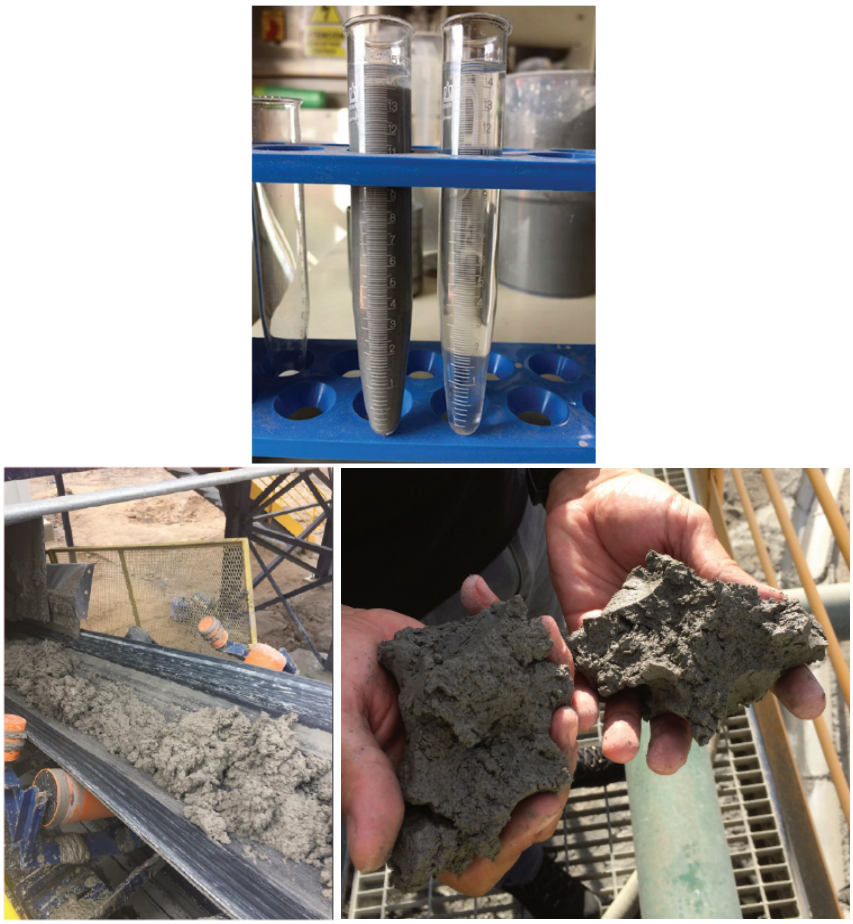


Figure 6 Photos of feed, recovered centrate and discharged solids

To save money on solids transportation the customer set the centrifuge to discharge a pasty solid discharge without free water, the benefit is that the discharged solids will behave like lava discharge from a volcano and flow by natural gravity into the designated depression close by.

Figure 7 Photos of solid discharge of four centrifuges, flowing by gravity into natural depression

Table 1 Operating parameter in Argentina

Parameter	Value
Feed flow rate	up to 60 m^3/hr
Feed solid concentration	27% by wt.
Solids feed rate	up to 25 t/hr
Drum speed	1,000 rpm
Centrifugal force	5,101 m/s^2 (520 x g)
Solids in centrate	< 500 ppm
Solids concentration in cake	65% w/ flocculent (Customer Requirement)
Operational power consumption	30 kW main drive, 45 kW scroll drive
Flocculent consumption	0.2–0.4 kg/t dry matter

CONCLUSION

The use of centrifuges for dewatering tailings is a viable alternative to existing technologies. Based on environmental impact, space requirement and investment cost, the mechanical separation of solids and liquids by centrifugal force will find its way increasingly into modern mining and minerals processing operations.

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