Tailings dam technology: learning from failure (Part 1)

Water security makes tailings dam technology a key hurdle for South Africa's mining growth, writes Adriaan Meintjes.

South African mines are quickly beginning to realise that key decisions on new mining projects or expansions simply cannot be made until the question of water security is resolved. This puts the focus squarely on tailings storage facilities (TSFs), which is the largest consumer of water on most mines.

In water-scarce countries like South Africa, it is increasingly becoming necessary to direct our work towards the management of water as a scarce natural resource for security at mine level. Indeed, our efforts to help mining clients become 'water wise' have included technical studies, advice, and even enabling technologies — all contributing to greater water security.

It is therefore no surprise to us that, in recent years, our clients have engaged us at the initial stages of project conceptualisation and design, to help optimise the tailings dams with water security in mind.

Saving water from mine tailings

Water consumption on a tailings dam is a function of the interstitial storage (water held between the solid particles of fines), evaporation, and seepage. The relative

Water security is key to the mining industry in South Africa.

Leon Louw

> Water security on a mine can be described as the reliable availability of acceptable quantities and qualities of water to allow production and treatment to proceed according to plan, with the management of an acceptable level of water-related risks. Additional available water, achieved as part of water security strategies, could mean increased mine production — which conversely could be limited by less available water.

significance of each can be estimated as follows: While interstitial storage amounts to between 25% and 35% of the tonnes processed, this means that there will be about 0.25–0.35 cubic metres of water 'locked up' in this way per tonne of tailings deposited on the TSF. Water lost through seepage could be as much as 0.1–0.35 cubic metres per tonne (depending on the nature of the tailings and the in situ foundation materials below the tailings dam), while the evaporation could be 0.15–0.45 cubic metres per tonne. In total, then, about 0.5–1 cubic metre of water per tonne of tailings is generally lost to the mine in conventional tailings dam designs.

By addressing each of these three factors, mines can considerably reduce water loss, making it more readily available for recycling and re-use. For instance, achieving a higher rate of rise on a tailings dam — which can be done through the use of cyclones — will have a direct effect on evaporation: an increase in the rate of rise from 2.5m per year to 5m per year will halve the evaporation rate.

By the same token, installing a liner can reduce seepage and allow that water to be recovered for re-use. South Africa has followed a worldwide trend to provide liners under tailings dams, allowing increased water recovery and reduced risk of polluting groundwater. National legislation and the regulatory requirements from the Department of Water and Sanitation now insist on liners for tailings dams, unless an acceptable risk mitigation plan can be presented to argue why liners would not be required.

Dealing with interstitial storage

To deal with interstitial storage, various options are available. Taking the route of paste tailings — using a high-rate thickener and positive displacement pump — will not drastically improve water recovery (perhaps by only 0.05–0.1 cubic metres per tonne of tailings), although this strategy can positively affect water management on top of the dam. To save water more effectively, it will be necessary to adopt the filtered tailings approach — which can substantially improve the recovery of water that is stored interstitially. Producing filtered tailings may also obviate the need for a liner, as the amount of seepage possible after filtering is insignificant.

While filtered tailings technology has been employed for many decades on mines in South Africa and elsewhere, its use has generally been limited to small portions of the material stream — often related to just the final concentrate, for instance. It is significant that in one recent local project, a

> Water saving on mines is not without its side-effects: more recycling means that the tailings water circuit becomes more saline over time, and increased salinity has an impact on the properties of tailings. High salinity with finer grind reduces tailings density and therefore reduces shear strength, while also creating greater risk of groundwater pollution. This requires a good, low-cost technology to be developed to remove the salinity.

> Water recovery using filtering technologies may increase additional recovery of metals remaining in solution, which normally would have been disposed of with the tailings on the TSF.

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Tailings storage facilities are the largest consumers of water on South African mines.

mining company will be employing filtration to treat as much as half of its tailings output, producing some 100 000 tonnes per month of filtered 'dry' tailings. So, this sort of solution is by no means unaffordable, although the industry must certainly get to grips with the substantial costs involved and build these effectively into project viability costings.

The fact is that there is a growing push to address water security alongside a range of environmental imperatives, and mines are required to take these very seriously to safeguard the sustainability of any new mine developments or expansions. There is already a realisation among certain of our clients that filtration technology will play an increasing important role in projects they are currently working on.

Another important benefit of filtered tailings is its impact on the closure costs, timelines, and responsibilities that are legally carried by mining companies. It should be remembered that wet tailings dams could take anything from 20 to 100 years to dry out, even with under-drains (depending on their size and various other conditions). Taking advantage of filtration allows this time goal to be achieved immediately, resolving a range of post-closure rehabilitation responsibilities such as dealing with seepage water. While the upfront cost of filtration may seem high initially, there are considerable savings and risk reduction further down the line.

Indeed, most mining companies are increasingly concerned about the long-term liabilities potentially created by their mining operations, and so any strategies that remove or resolve these liabilities sooner rather than later need to be seriously considered. The question is often not just about the cost of the early solution — a more pressing concern may be related to whether the required skills and teams will be on hand to diligently deal with long-term obligations to the standard that compliance requires. The widespread commitment of the mining sector to best international practice in sustainability and environmental management would certainly suggest that we are likely to see more concerted application of technologies previously considered very costly. Filtration has various positive impacts that include safety, risk reduction, and cost-savings.

The placement of filtered or dry tailings, for example, can make for more manageable and safer tailings facilities; safety in TSF design and management is a topic I shall address in the next article in this three-part series.

Returning to our specific concern with water security, it is clear that bold science-based strategies are the only way forward. Water is a scarce natural resource and the ongoing evolution of ethical behaviour as an industry, demands that we minimise our consumption of these resources with all the technology at our disposal.

The article is the first in a series of three on "Tailings dam technology: learning from failure". MM

About the author

Adriaan Meintjes is principal civil geotechnical engineer at SRK Consulting South Africa. Adriaan has been involved in civil and geotechnical engineering for over three decades and has worked for SRK Consulting South Africa since 1992. His speciality areas include soil and rock mechanics, numerical modelling, foundation design, water and tailings dams, and risk assessment.

SRK Consulting is a global network of engineers and scientists. Much of its early reputation was earned from its work on tailings storage facilities and working closely with mining companies to develop science-based innovations to make tailings dams safer and more environmentally sound. Today, SRK is a multidisciplinary operation with a depth of expertise relevant to mining, infrastructure, environment, energy, and water.

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