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How do filtering solutions stack up?

Improving mine tailings management is now on the minds of every responsible mining company, and finding ways to prevent against worst-case scenarios remains a top priority in the industry worldwide.

Dry stack tailings are a way to avoid the pitfalls of tailings dams

Surface Mining > Tailings

This comes after a bruising decade that witnessed some of the worst tailings disasters the world has seen. Communities in northern British Columbia, central Brazil, and New South Wales are still dealing with the ramifications of these dam

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failures, while mining companies are proposing mine plans which vastly increase the amount of ore required for storage.

Increasingly, mining companies are using what they've termed ‘dry stack' tailings as a way to avoid the pitfalls of tailings dams and their potential for spillage.

Eldorado Gold Mining will be using this tailings management approach at its Skouries gold mine in Greece, Hecla Mining is applying this method at its Greens Creek silver mine in Alaska, and a host of iron ore projects in Western Australia and Brazil are working with this tailings format.

However, experts warn that the dry stack approach may not work for every mineral deposit.

The label of ‘dry stack' is itself a misnomer, Newport Mining's Senior Director for Tailings Management Kim Morrison told *Mining Magazine*. She also edited Society for Mining, Metallurgy & Exploration's Tailings Management Handbook this year.

ailings are not dry, but dewatered to soil-like consistency," she said, adding at this form of tailings has a turation that ranges from 50% to %.

better term for the process is filtered ilings, she said.

nplementing a filtered tailings pproach to tailings requires a few additional processes, Dave Christensen, senior engineer at mining consultancy Okane Consultants told *Mining Magazine*.

Mining companies will proceed with ore development as usual, and as the ore goes into the mill, it will undergo the same processing circuit in order to capture the metal of interest.

In a scenario where a tailings pond is the container of choice for mine waste, conventional tailings would be slurried and then piped out to the dam, he said.

"For dry stack tailings, there's one additional process within the mill, or it could be several processes," Christensen said.

"There's the process to extract the additional water out of the tailings. There could be some sort of chemical addition, or floculant, to get the water out and get the solids to accumulate."

This process is often followed by a physical filter press, which will compress the tailings to push the remaining water out of the remaining waste.

"This means you could end up with a higher solids content, creating a sand-like material," Christensen said, adding that it depends on the practice.

Mining companies will then transport the dry-stacked tailings, either by haul trucks or by conveyor systems, to move the waste out to the tailings area, after which the waste is treated as more of a solid material.

These extra processes will come at a higher cost, Christensen said.

"This requires additional processing with your mill, and you will need a lot of equipment to achieve the physical process of extracting the water," he said.

It will also require additional energy resources, which are already high in most mining and milling operations.

Understanding the underlying characteristics of the materials is critical to a safe filtered tailings operation, Tyler Birkham, senior geoscientist at Okane Consulting, said.

"Geotechnical stability is a key focus," he said. "It is important to understand the tailings. The seepage water quality for whatever mine product is definitely of high concern, so understanding the geochemical properties is important."

If filtered tailings have open pore spaces where oxygen can enter, the presence of this oxygen can lead to mineral oxidation.

"This can have water quality impacts of metal leaching," Birkham said. "It might not be an issue - the sulphide mineral concentration might be low and not an issue in the dry stack form, but it also might be. It's important to understand the risk."

There are multiple benefits to using the filtered tailings approach, if it fits with the characteristics of the mining project, Morrison said.

One of the top benefits of using this process is the reduced need for space. Wet tailings storage facilities require substantial structures to safely contain 50,000 cubic metres or more, and will also need embankments of five meters or higher.

Filtered tailings "require a smaller footprint for storage, are easier to reclaim, and they do have a reduced long-term viability relating to the structural integrity of the facility itself," Morrison said.

Filtered tailings will also work best in areas with limited water resources, she added.

"It's very attractive for projects in arid regions, where water conservation is an important issue," she said.

The applicability of filtered tailings will also depend on a mine's throughput rates, she said.

"Filtered tailings work for mines that produce less than 30,000 tonnes per day of tailings," she said. "There have been some proposed mines that have demonstrated viability for filtering at much higher rates, from 60 tpd to 80 tpd. But so many operations out there that are well over 100 tpd, this has not proven viable."

Cold weather poses challenges

Filtered tailings also works best in cold regions where water handling is challenging for portions of the year, Morrison said.

There are constraints and opportunities for filtered tailings in cold regions, SRK principle geotechnical engineer Daniel Neuffer told *Mining Magazine.*

Frozen conditions can lead to increased chemical stability of the tailings, he said.

"However, one important point is the consideration of climate change and the [ensuing] degradation of frozen conditions in dry stacks," he said. Far northern climates have seen an increasing warming rate in recent years, leading to increasing periods of melt.

Another factor of filtered tailings in colder climates is the impact of frozen tailings and density.

"If tailings freeze, it can be hard to compact," Neuffer said. "If it can't compact, it may not be achieving that higher density and higher strength condition, so you'll end up with lower density," which is problematic for maintaining the stability of the tailings.

Monitoring the density will be different for different sites and will depend on a number of factors, which include the height and angle of the slope in which the tailings are placed, he said.

At the nearby Pogo gold mine in Alaska, mine operators conducted site-specific tests and exposed the tailings to different temperatures. This way, the operators were able to determine the maximum amount of time tailings could be exposed to specific temperatures before it affected compaction rates.

One of the major issues facing filtered tailings management is the increase in ore production worldwide.

"We had a project recently in northern Eurasia, and it had a very large height, larger than any operating stack on the order of 200 to 300 meters," he said. "Bigger stacks are becoming more of a reality."

Larger stacks will mean that the stability of tailings will be highly dependent on the density of the filtered tailings.

"The more dense the soil is, the stronger it is," Neuffer said.

"Grading for damage and compaction is important to keep water from ponding and infiltrating the tailings," he said.

Mining companies can also use multiple cells for tailings storage to avoid problems, he said.

"Different operations have different strategies," he said. "At [Hecla Mining's]Green Creek, tailings are brought down in covered trucks to keep out water, then they place the tailings in areas to allow them to dry them out more, and for water to squeeze out."

Mineworkers will then come back to these areas to compact these tailings, he said.

More than just one alternative

There are alternatives to wet tailings storage and filtered tailings.

Mining companies can improve their tailings management processes by using rheology, or thickening of the tailings, Morrison said.

"This provides many of the same benefits as dry stack tailings," she said, and also improves water management throughout the mining process.

Generating paste tailings also provides some benefits, Morrison said, adding that Newmont uses paste tailings in some operations as backfill in underground operations.

"There are geochemical benefits to this approach, and it allows us to mine the resource more economically and safely," she said.

Another approach is "cycloning".

"This separates the coarse from the fine tailings," she said, with the coarse tailings can be repurposed for sand dam construction. Developed in the 1960s, cycloned sand dams were first used at the Brenda copper-molybdenum mine in British Columbia, and are often used in South Africa as an alternative tailings approach.

Cycloning also makes sense in geologically unstable geographies, Morrison said.

"It's a commonplace technology in seismic zones like Chile, and is robust," she said."

Another option that Newmont Mining has been looking at is the construction of integrated waste landforms.

"It's not a dam per se, but an embankment constructed as a waste rock facility," she said. "The possibility of a catastrophic release of tailings is significantly reduced" using these kinds of facilities.

Also of interest is the option of constructing surface tailings facilities, in which tailings are placed in open pits and eliminating the use of dams altogether.

"At Newmont, we're looking for opportunities for additional in-pit dams," Morrison said.

The benefit of in-pit dams is that there is no possibility of wall collapse, or toxic tailings spreading to local ecosystems and communities. Mining companies do not need to build retaining walls, which significantly cuts down on the costs. Not needing to design separate facilities also cuts down on expenses for tailings storage.

However, one downside of this approach may be the decreased stability of underground mines that are located nearby an in-pit tailings storage facility.

One alternative which both Okane Consulting and Morrison are also encouraged by is commingling.

"There's been a lot of work done on this," Morrison said. "What it does is it mixes tailings with waste rock. This can provide geochemical benefits if one of the materials [in the tailings] has the potential for acid generation if it oxidises."

By placing both these materials together, tailings - particularly fine tailings - will plug up any holes in the waste rock, to prevent oxidation from happening. By blocking off oxygen from entering these small spaces, commingling reduces the likelihood of acid forming and then leaking into groundwater.