Case study

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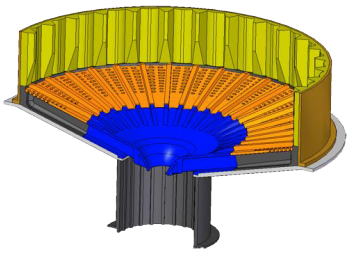
How an issue with SAG mill dischargers became a nine-year-and-counting collaboration

With its two SAG mills suffering a range of performance issues, a polymetallic mine in Mexico invited us in to assess the situation.

Nine years later and our partnership with the mine had yielded a range of solutions that have significantly improved mill performance.

Discharge head liners: SAG 38' x 22' 6"
Original steel liner design



Centre Cone | **Centre Cone Plate** | **Outer Pulp Discharge**

Item	Weight	Quantity
Centre Cone	2,452 kg	18
Centre Cone Plate	741 kg	18
Outer Pulp Discharge	2,781 kg	36
Total	**157,590 kg**	**72 pieces**

FIG 2: The original 72-piece design for the discharge system took a lot of time to install, due to the number of pieces.

SAG mill in need of help

An open pit polymetallic mine northwest of Mexico City, producing gold, silver, lead and zinc, was experiencing problems with the steel linings of its two 38 ft diameter SAG mills. The mine had developed a new design that used extended outer linings on the discharger and eliminated the middle liners. The new design was intended to reduce the number of lining pieces in the discharger and to shorten installation time (Figures 1 and 2).

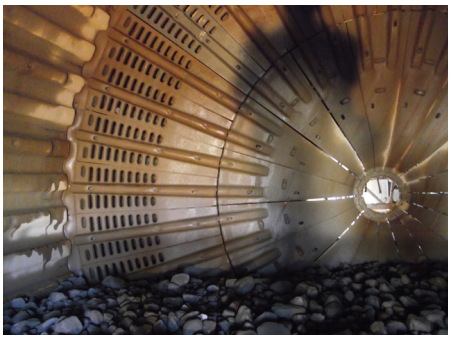


FIG 1: The original steel liners of the dischargers were having problems with bolt breakage and excessive wear on the center cone, generating a large back flow of fine material to the mill. This reduced mill efficiency, increasing energy consumption and reducing mill throughput.

FIG 3a: (Before) The large gap in the centre cone that caused that backflow of fine ore into the mill.

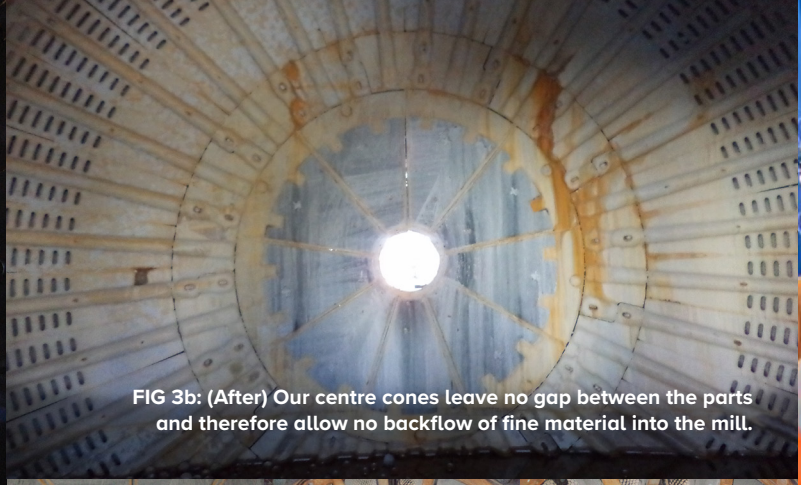


FIG 3b: (After) Our centre cones leave no gap between the parts and therefore allow no backflow of fine material into the mill.

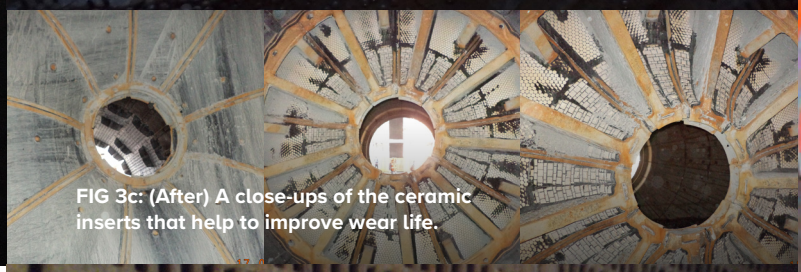


FIG 3c: (After) A close-ups of the ceramic inserts that help to improve wear life.

The steel design had some unintended consequences, however:

- Bolt breakage that led to pulp leakage from the discharger into the mill's hydraulic system, causing significant downtime. The broken bolts also needed to be replaced – a time-intensive activity. As a result, the mine was struggling to meet the mill's designed throughput.

- Excessive wear in the centre cone of the dischargers that left large gaps between the cones and resulted in the flow of fine material back into the mill, reducing grinding efficiency (Figures 3a-3c).

Getting up close to the problem

This was back in 2011. We were invited to the mine to inspect the mills – with the mine shutting down the mills to enable our team to carry out a thorough evaluation of the problems and suggest opportunities for improvements. Little did we know that that visit would be the start of a nine-year (and counting) relationship.

When onsite, we could see the contaminated water coming through the bolt holes in the discharge cones, where the bolts had broken. In addition, our engineers discovered a number of other issues:

- The trommel panels were not lasting long enough and did not have enough open area (Figure 4).

- The water spray in the trommel was causing fine materials to stay in the trommel overflow, instead of being classified in the trommel (Figure 5).

- The trunnion adapter was unprotected, resulting in high levels of wear to the bolts. The trommel adapter was also wearing out (Figure 6).

FIG 4: The original trommel polyurethane panels had poor wear life.

FIG 5: Performance of the old trommel water spray system was poor, due to uneven water distribution.

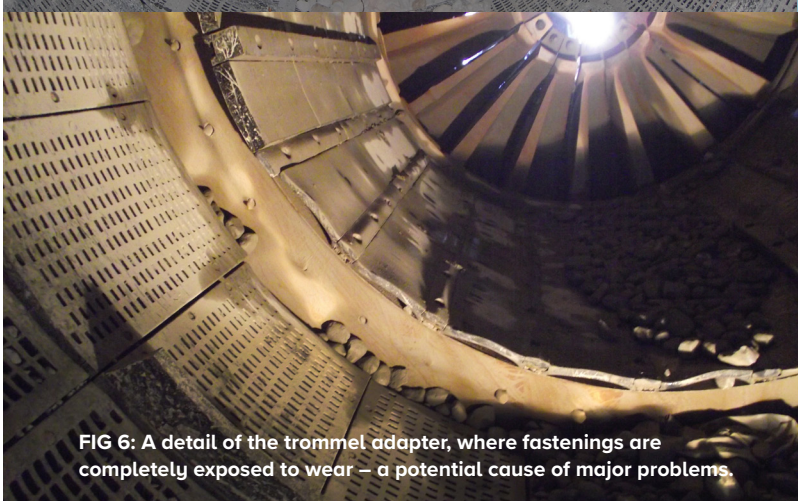


FIG 6: A detail of the trommel adapter, where fastenings are completely exposed to wear – a potential cause of major problems.

FIG 8: Made of rubber, steel, hard-wear steel, and ceramics, the PulpMax outer pulp lifters are ready to be shipped to the customer.

Discharge cone
Steel vs PulpMax™

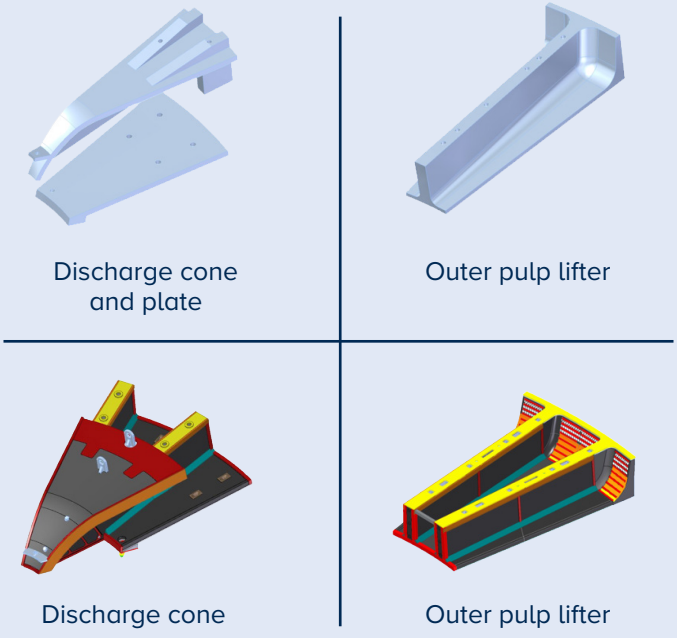


FIG 7: A comparison of the old (above) and new (below) designs. Note the PulpMax centre discharge cones are double width and upper and lower parts are unified in a single piece. Made from composite material, the outer pulp lifter is also double width, but only about half of the weight of the steel liner.

Finding the solution

After seeing what needed to be done, we were able to support the mine with solutions that addressed the challenges and helped improve SAG milling performance.

To start, we optimised the discharger design to reduce the number of parts from 72 to 27 (Figure 7). Assuming average installation time of 6-10 minutes per piece, this results in a reduction of between 4.5 and 4.7 hours in installation time during maintenance. We also added hard steel and additional ceramic elements to the discharger liners to improve wear life (Figure 8).

These changes were successful in solving the discharger issues. Based on this, the mine gave us the opportunity to provide solutions to the other issues we had identified.

FIG 9: The heavy duty trommel panels manufactured from high wear-resistant rubber

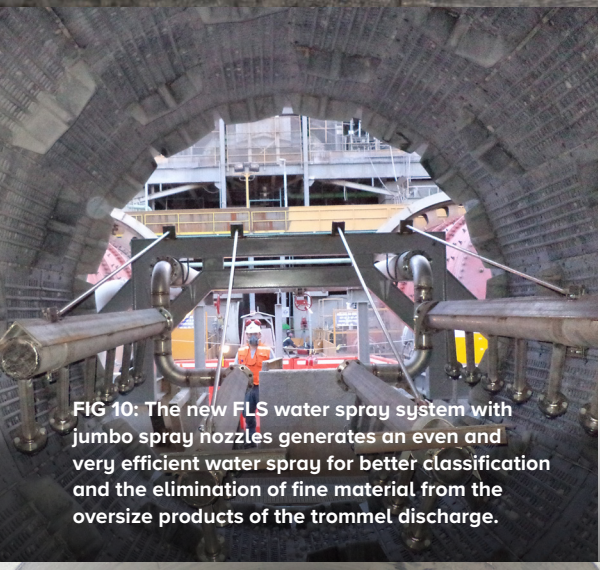


FIG 10: The new FLS water spray system with jumbo spray nozzles generates an even and very efficient water spray for better classification and the elimination of fine material from the oversize products of the trommel discharge.

FIG 11: We are supplying the customer a new polyurethane seal system that ensures there will be no leakage from the feed chute to the feed trunnion of the SAG mill.

One success opens the door to further collaboration

For the trommel panels, we altered the thickness, improving the open area and DAM profile, using our special rubber lining to increase the wear life from 3 months to 5 months. Previous polyurethane panels had been attached with pins, but the new rubber panels use a rail system that allows much faster and safer installation during maintenance (Figure 9).

The trommel water system was also completely replaced with a system comprising four water tubes and polyurethane 'jumbo' nozzles. These provide better wear life and spray pattern, ensuring the fine material was classified through the trommel, rather than building-up in the trommel overflow, as it had been doing (Figure 10).

Trunnion liners were changed for a heavier-duty design with the aim of doubling wear life, compared to the original design. And we designed a new seal to avoid slurry leakage from the feed chute of the SAG and ball mill – with the new design installed in 2014 (Figure 11).

A relationship built on trust

It has been a long – but rewarding – road working together with the mine to ensure the SAG mills provide the performance it needs. Nine years of collaboration, during which we have built a strong relationship with the mine on the basis of our proven technical solutions.

The result of this work has resulted in a range of improvements:

- 42.5 fewer hours of downtime due to bolt breakage.
- 54% reduction in discharger weight.
- 45 fewer parts per discharger set.
- Increase in the wear life of the dischargers from 303 days to 373, the equivalent of going from 16 million tonnes to 20.3 million tonnes of production.
- Increase in the wear life of the trommel panels.
- Improved trommel efficiency due to new panel DAM design and upgraded spray system.
- Installation of PulpMax dischargers has stopped the pulp leakage at the discharge head.
- Higher grinding efficiency and reduced power draw due to reduced backflow of fine material (that was previously caused by poor steel discharger performance).

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