CRUSHING DOWNTIME WITH NEW OIL

Jim Thomas, Lubrication Engineers, USA, addresses how the right choice of lubricant can boost operational efficiency and prevent costly failures.

After repeated failures of its crushers caused production losses, a large copper mine's Maintenance & Reliability Team knew something had to change. In this case, it was the gear oil protecting its bushings. With this one change, they increased equipment availability to production by 2.2% – a remarkable improvement in the mining world. They also reduced lubricant usage by 83%, resulting in cost savings and a reduction in safety risks and carbon footprint. Total annual savings exceeded US$2.8 million.

The mine, located in South America, was having to undertake full rebuilds up to five times a year on the bushings of each of its two primary crushers, resulting in excessive production losses. The mine processes more than 280 000 t/d with these two crushers. This excessive unplanned downtime was largely caused by tramp metal ingested by the crushers.

When either of these two crushers ingests a shovel tooth or other metal object greater than 9 in., it typically causes irreparable bushing damage, which necessitates full rebuilds (Figures 2 and 3).

The crusher in Figures 2 – 5 had been lubricated with a 'premium' gear oil, which was filtered with a 20 µm filtration system. ISO particle counts typically ran at 24/22/18. The introduction of tramp metal initiated extreme pressures and temperatures that would last as long as needed for the metal to clear itself. Once, the crusher came to a complete stop due to the sheer size and mass of the ingested metal. Each of these tramp metal incidents started a cascade of events that literally toasted the bushing and its base plate.

When looking at these failures, it is helpful to focus on the particles generated from the tramp metal ingestions.

Figure 1. This large South American copper mine has two primary crushers feeding its process line. Collectively, the line processes over 280 000 t/d.

Other sources of contamination were also present, but they were insignificant in comparison to the tramp metal.

Lubricant failure leads to primary and secondary damage

The oil's foremost responsibility is to keep lubricated metal surfaces from touching each other. When the oil fails at this task, contamination particles are generated and certain types of wear appear on the metal surfaces. This wear can be classified as 'primary damage'. Particles created from primary damage can be very abrasive depending on their source. Those formed from soft bearing material might be the least destructive, while those formed from hardened steel are especially destructive.

Particles from primary damage tend to create their own damage by lodging between metal surfaces and creating new particles. This is 'secondary damage', and is a direct result of particles from primary damage creating additional particles in a cascade effect. During the life of an oil change, the cascade can go as high as 19:1 in a diesel engine. Gear trains are less, but 10:1 is not unusual.

Figure 2. The crusher's 110 t mantle is extracted, exposing the damaged bushing.

Figure 3. The outer bushing surface shows severe damage from extreme pressures, high temperatures, and burnt oil.

Stopping the primary damage will have a large impact on the amount of secondary damage. When comparing Figure 4 to Figure 6, it is evident that the extreme pressure additive in the lubricant is imperative to the lubricant's success. The EP additive in the gear oil being used in the crushers had failed to stop metal-to-metal contact. The resulting particle generation was immense, as was the creation of secondary damage particles that followed.

Each tramp metal event caused the level of damage shown in Figures 2 – 5. The mine's Maintenance & Reliability Team thought it was impossible for gear oil to do anything to stop such catastrophic failures. They examined the current physical procedures on tramp metal elimination and determined they were at a high standard, with only minor tweaking required to maximise current processes.

The only exception was the older stockpiled material they occasionally used. Although purported to be clean, its composition is largely unknown with respect to tramp metal. It had been accumulated before current tramp metal remediation practices were applied. The mine has a significant amount of this stockpiled material that requires processing. Given the sheer volume of this material, it must be processed with the two crushers. The challenge for the team was to stop the crusher failures.

The crushers are considered critical assets, for which unplanned downtime has severe production and cost consequences. Ongoing losses associated with this problem had to be resolved, and could not be considered business as usual. Given the stockpiled material could not be improved, focus was directed toward the bushing destruction and what, if any, preventative options were available.

It was determined the gear oil being used to protect the bushing could not withstand the spike in extreme pressure caused by a sudden stoppage of the mantle. Therefore, it was time to look at oil again. The crushers were critical assets that required a critical lubricant, as repeated failures had demonstrated that routine lubricants were not meeting their needs.

After the team tried various suppliers' maximum pressure gear oil products with no discernible difference, the mine's senior reliability superintendent approached Jim Thomas of Lubrication Engineers (LE) about this issue. Thomas had supported several North and South American mine sites for over a decade with lubrication, filtration, and monitoring devices and has achieved previous success with this application.

The superintendent said that the mine continued to have significant issues with the crushers' inner bushings, where tooth ingestion created significant metal debris and high return oil temperatures. He added it was common for them to change this bushing due to it being burned.

He stated this problem would likely prevent the mine from achieving their next planned maintenance interval, which was becoming the norm. It also was having a significant negative impact on its ability for continual processing downstream.

New oil puts stop to failures

As an initial measure, Thomas suggested conducting a trial with a synthetic gear oil containing a unique and proprietary extreme pressure additive – Duolec – which was developed by LE and is not available from other suppliers.

The result of this trial was an immediate halt to the catastrophic failures. After the new oil was applied, the tramp metal ingestions continued, including four more from shovel teeth and a large steel plate. One of these ingestions even brought the system to a complete halt; however, the new gear oil – Duolec Syn Gear Lubricant – protected the bushing, and no rebuilds were required after clearance was achieved. The convex bearing and base plate were also unscathed.

The oil and its additive package put a stop to nearly 90% of the primary damage. Figure 6 shows the immediate impact of this. Current ISO readings are 20/18/16 and relatively steady. Secondary damage remained the same because the filtration system was not changed.

Critical assets require the right lubricants to minimise unplanned downtime and costs. Each bushing change costs US$360 000 in lost production, parts, and labour. During the past 12 months since implementing use of the advanced EP gear oil, the mine's two crushers combined have avoided eight rebuilds.

After one year, the Maintenance & Reliability Team has documented the following results:

- Total annual savings exceeded US$2.8 million.
- Availability to production increased by 2.2%.
- Payback was achieved in less than two months.
- Lubricant usage dropped from 12 000 to 2000 gal./y for both crushers, resulting in cost savings, as well as a reduced carbon footprint.
- Safety risks lowered due to less unplanned maintenance.

Next step: Filtration and monitoring

With regards to secondary damage, the expense of the lubricant can be defrayed if it is kept clean, cool, and dry. Superior filtration can enable use of the same oil for up to five years, while upgrading the filtration system would further improve the mine's results.

A new depth media filtration system – CCJensen HDU 4x27x108 – is set to be added to the mine, which will remove 99% or more of particles to 3 µm. This will greatly reduce secondary damage and effectively extend the oil life to five years.

An oil monitoring system will provide insight into real time oil contamination levels (ISO 4406), water intrusion, oxidation, temperature, and pressure. With the addition of VeriTAI vibration analysis, the programme can provide up to three months of advanced notice of impending maintenance issues, giving the Maintenance & Reliability Team time to plan. It also answers the question of whether the equipment will keep running until the next planned maintenance.

Lubrication is a very small part of an operating budget, typically 3 – 5%. However, it literally touches every rotating and moving surface. In this case, use of the LE gear oil for the critical asset added 2.2% availability to production for a relatively small increase in cost with a payback of less than two months. This kind of leverage can be available for any critical asset. GMR

Figure 4. The scorched inner bushing surface shows long structural cracks, with the longest being 4 ft in length.

Figure 5. Scorched oil-races on base plate bearing of the mantle shaft.

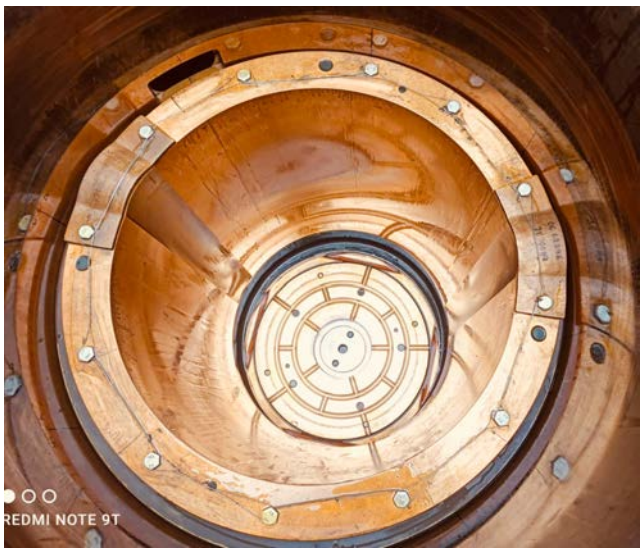

Figure 6. Eight months and five tramp metal ingestions later, the crusher's inner bushing remains in good condition.

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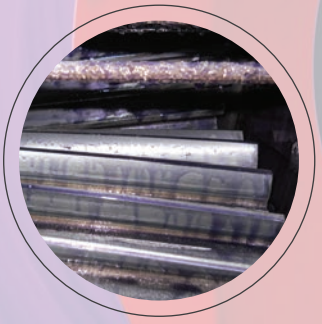

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