White Paper

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TITLE: Magnetic Separation Techniques to Improve Grinding Circuit Efficiency – 2014

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Grinding Ball Fragments in the milling circuit impact on two critical areas. One is the crushing circuit where companies have observed damage to crushers, unscheduled downtime and loss of production. The other is the grinding circuit where companies have discovered wear to pumps, sumps, piping, hydrocyclones, mill liners as well as inefficient grinding, power consumption and optimization of mill throughout overall.

After reading this article, the reader will realize why a trunnion magnet offers a significant return on investment with tremendous cost savings.

* The Trunnion Magnet is an enhanced system for the separation and removal of balls and broken ball pieces typically used for ore processing in ball/SAG mill operations. Depending upon mill capacity, ball size and other parameters, Eriez will select and specify the appropriate construction features.
Figures 1 and 2 indicate respectfully the damage a grinding ball did to a cone crusher mantle—and the accelerated wear to a pump impeller as an example of the equipment imparted by recirculating steel scots. This results in costly repairs, often unscheduled downtime and loss of production.

Fig. 1. Cone Crusher Mantle damaged by a grinding ball - ultimately resulting in costly repairs, unscheduled downtime and loss of production.

Fig. 2. Accelerated wear to pump impellers, and all other process plant in contact with or impacted by recirculating steel scats.

* Figures 1 and 2

Here are four applications/circuit locations accompanied by a recommended equipment solution. Each has its own set of challenges, and each is approached in a different manner.

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**Pebble Crusher**

Figures 3 and 4 shows the location of a suspended electromagnet over a pebble crusher conveyor.
In this application, over the overhead pulley is preferred to the cross belt position (See Figure 5). A magnet width must be utilized to provide the most effective burden width coverage. The smallest size and shape of the tramp (steel scats) to be removed dictates the size of the magnet. Other considerations include the burden depth, belt speed, capacity, as well as clearance to the magnet and specification of a self-cleaning belt.
SAG Mill Vibrating Screen Deck

By placing a magnetic drum over a vibrating screen (Figure 9,) an installation will realize a number of benefits:

- Provides a relatively slow-moving ore
- Eliminates the dead burden of a conveyor belt, since this is essentially a mono-layer approach. (See Figure 10)
- Agitates material to aid the physical release of entrapped steel scats.
- Able to place magnetic drum close (150 to 250 mm) to discharging ore.
- Effectively remove long rods before they spear and damage the conveyor belt.
Ball Mill Discharge

Figures 11 and 12 indicate how a trommel screen is replaced by a trunnion magnet system. The trunnion magnet is mounted at the ball mill discharge point.
There are significant advantages and measured improvements when a trunnion magnet is installed (Figure 13):

- It eliminates the higher capital cost of a trammel screen and the maintenance it requires.
- It extends pump and hydrocyclone life that has been documented at 250%.
- It increases mill throughput 5 percent.
- It reduces mill power consumption 8%.
- It results in 10% reduction in the mill work index due to more efficient grinding.
As part of this article, there are two Ball Mill Calculations comparing conventional ball mill power consumption (Hogg & Fuerstenau Model) before tramp steel removal (Figure 14) and after tramp steel removal (Figure 15). These calculations indicate the ball charge is reduced from 678 tons to 585 tons (target ball loading).

* Figure 14 (Before Tramp Removal)

* Figure 15 (After Tramp Removal)
Three other figures 16, 17 and 18 indicate how ball mill tonnage is consistently greater after the trunnion magnet is installed, while energy savings also occurs. In addition, the mill work index dropped impressively.

* Ball Mill Tonnage

* Figure 16
**Figure 17**

Ball Mill Total kW

![Ball Mill Total kW graph](image)

**Figure 18**

Ball Mill Index in kWhr/T

![Ball Mill Index in kWhr/T graph](image)
At the Kemess Mine, the effect of a trunnion magnet system on the ball mill was significant. The total mill feed remained essentially unchanged averaging approximately 1300 TPH. However, the total mill power consumption dropped 8% from an average of 7600 kW to 7000 kW. The mill work index dropped 10 percent from an average of 5.5 kW-hr/T to 5.0 kW-hr/T.

Conclusions

This represents a current view of the effects of grinding ball fragments in the milling circuit and the impact on the crushing and grinding circuit. The performance of a trunnion magnet should be compared to the existing operations especially if cost savings and output need improvement. Retro-fitting a ball mill with a trunnion magnet is easy to accomplish, particularly when the benefits are weighed against the cost. There are approximately 150 installations of trunnion magnets around the globe.