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Navigating Operational Hurdles in SAG Mills: Identifying and Addressing Common Challenges

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ABSTRACT

This paper explores prevalent operational challenges encountered globally in SAG mills, including suboptimal throughput, liner wear, excessive energy consumption, and SAG mill load stability. The paper delves into the root causes behind these issues, such as ore variability, poor operating strategy, or inadequate process control. Drawing on industry experience and case studies, the paper highlights the significance of addressing these challenges to enhance overall mill performance and efficiency. It underscores the necessity of tailored strategies, encompassing improved monitoring, optimized liner designs, and refined control techniques to mitigate these challenges and promote sustainable SAG mill operation.

INTRODUCTION

The semi-autogenous grinding (SAG) mill is the heart of the milling circuit and is often the primary throughput limiting constraint. The SAG mill load must be stable to maximize the SAG mill power draw to achieve maximum throughput [1].

There are challenges to maintaining a stable load in the SAG mill. These challenges are contributed, quite often, by interplaying variables related to the ore conditions (competency, hardness, size distributions, viscosity) performing in set mill-operating conditions. This paper explores the common operational challenges frequently observed through constraints assessments and operational optimization projects, highlights the root causes of SAG mill load instability, and provides a path forward.

Stabilizing the load within the SAG mill is the critical parameter in maximizing SAG mill performance. Yet, several factors influence it, including feed size distribution, the responsiveness of process control systems, and the design and state of wear and design of the mill liners and discharge grates [1]. A poorly tuned control system or suboptimal operator decisions can result in excessive control actions, leading to instability in mill operations. Proactive feed rate and mill speed management is essential in addressing these issues. Neglecting the wear state of mill liners can result in increased mill filling, which negatively impacts milling efficiency and throughput [2].

Objective of the Paper

To maintain a stable SAG mill load for changing ore competency and feed size distribution, the following key variables need to be manipulated, controlled or fixed (Figure 1).

The paper focuses on the following four opportunities and strategies for maintaining a stable SAG mill load, which are some of the key prevalent issues at most SAG-based operations—where immediate opportunities can be achieved:

Fixed variable	Input variable	Reactive variable	Setpoint variable	Constraint variable
• Liner design • Grate aperture • Pulp system design • Ball charge load (if maintained)	• Mill speed • Discharge density	• Power draw • Throughput • Mill noise • Mill load (total volume) • Pebble generation rate	• Load • Noise	• Power draw • Noise

Figure 1. Key variables affecting the stability of the SAG mill load (after [1])

- Maintaining a stable feed size distribution and consistent ore feed competency
- Recommended mill liner and discharge system designs
- Selecting suitable grinding media
- Recommended instrumentation and optimized process control

IMPORTANCE OF MAINTAINING A STABLE SAG MILL LOAD

Many operating variables (combination or separately) contribute to a SAG mill load's stability or instability in SAG mill-based comminution circuits. As the SAG mill duty changes based on the feed size distribution, the mill internals should be changed and configured, and the operating conditions adapted [3].

But why is maintaining a stable SAG mill load so important? A stable SAG mill load means the SAG mill is operating in the optimal mill filling range for efficient grinding as often as possible.

SAG mill load-instability results in the SAG mill operating in the low load zone, resulting in liner and media damage or in the high load zone, resulting in poor breakage efficiency and resulting lower throughput.

The normal mill filling operating range is typically lower than the peak mill power draw [4] when the mill is operating at a nominal speed of 75% critical speed - as shown in Figure 2. The SAG mill power drops off at very high total fillings due to the shift in the center of mass of the charge towards the center of the mill outweighing the increased mass of the charge [5]. The shift in the center of mass results in a reduction in mill torque, thus a lower power draw.

For a SAG mill operating with nominal speeds, suitable liner and discharge system design, the feed rate follows a similar trend as the mill power draw when plotted against total mill filling, reaching a peak feed rate, and then decreasing with increasing mill fillings [5]. The feed rate peak normally occurs at lower mill fillings than the power peak [4]. The power and throughput peaks converge with increasing mill speed; therefore, using maximum SAG mill power draw can be an appropriate measure in the scenario that SAG mill throughput is maximized. Increasing the SAG mill load stability and operating at the optimal mill filling, increases the amount of operating time at the peak of the power and feed rate curves.

It is not uncommon for operations to have a poor understanding of the optimal mill filling and how the corresponding measurement of mill load, via a load cell, or bearing pressure translates. Operations will control the mill to a maximum mill load or bearing pressure value and allow for significant drift during normal operation. An example of a highly variable mill filling is shown in Figure 3. The operation measured the mill filling monthly but did not adjust the operating or control strategies to improve the operating range allowing the mill filling to vary between 13–30 %v/v.

There are several soft sensors commercially available that provide inferred mill filling measurements (LoadIQ

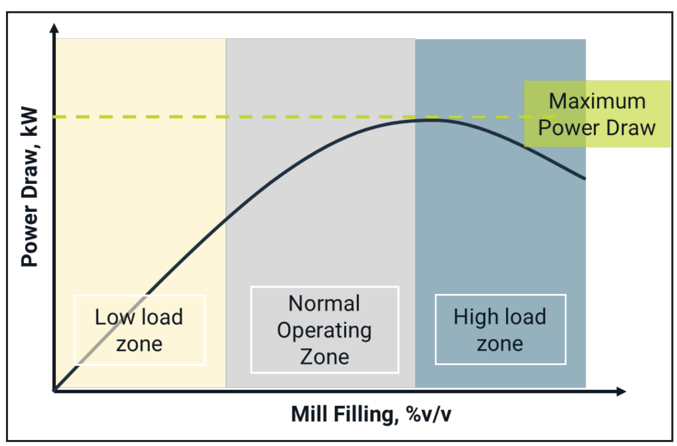

Figure 2. SAG mill operating zones

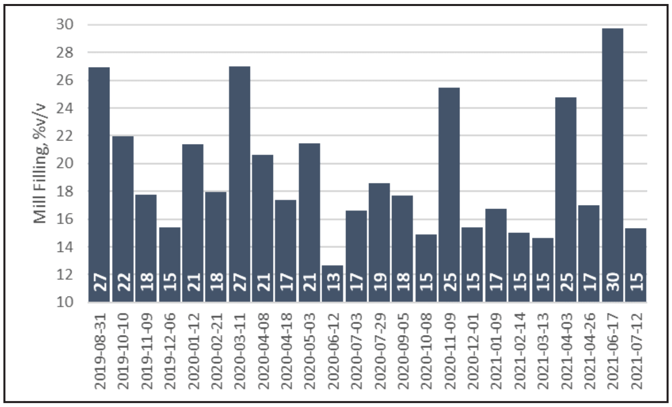

Figure 3 - Example of highly variable mill filling

[7], MillSlicer [7], etc.). These tools can be useful to the operator and tied into control logic for maintaining mill filling under variable operating conditions and minimizing direct shell impacts. Significant changes in ore-specific gravity, such as Phu Kham, make it difficult to control mill filling. Soft sensors allowed for a mill filling control strategy to be developed based on changing ore competency and specific gravity [8].

CHALLENGES AND SOLUTIONS TO MAINTAIN A STABLE LOAD IN SAG MILLS

The common operational challenges that impact SAG mill load stability are discussed in detail in this section.

SAG Mill Feed

Challenges—Causes of Variable Feed to the Mill

Variability in the SAG mill feed can be attributed to multiple sources including heterogeneity in the feed material or multiple pits, primary crusher control, and recycled feed from the pebble crushing circuit.

Ore competence refers to the ore's ability to break down into smaller particles under the applied force in the SAG mill. Variability in ore competence can significantly affect the milling process, achieving finer or coarser product based on the operating conditions. A highly competent ore is more resistant to grinding, requiring more energy to break down, resulting in lower throughput and finer product. Whereas a less competent ore leads to higher throughput and a coarser product. Therefore, developing a comprehensive understanding of ore competence and its variability and its impact downstream (grind size vs recovery) is crucial for optimizing SAG mill performance [9].

The causes of variable feed and its impact on the SAG mill load are:

- Primary, secondary, or tertiary crushed product fed SAG mills.

A significant portion of feed size variability is the result of operating practices such as allowing drift in the primary crusher gap, stockpile segregation, and stockpile dozing [2].

Drift in the primary crusher gap increases the top size of the feed to the SAG mill drastically impacting mill filling, throughput, and grind size.

Circuit design can impact feed size variability as well such as if the SAG mill is preceded by a feed bin or a coarse ore stockpile (COS). Segregation within a bin and the location of the feeders drawing from the bin can cause feed size fluctuations as the bin is drawn down, as seen at Newcrest's Cadia operation [10]. Segregation in a coarse ore stockpile can impact feed size, particularly with dual train circuits, where two SAG mill trains are fed from a single COS, as seen in Newmont's Penasquito operation [11]. Due to the asymmetrical draw-down of Penasquito's COS, one SAG mill receives a significantly finer feed distribution depending on the height of the COS. Penasquito's circuit has a secondary crusher line, feeding an HPGR prior to the SAG mill. Inconsistent HPGR operation led to frequent feed size fluctuations in the SAG mill.

Dozing of the coarse ore stockpile can cause significant fluctuation in SAG mill size due to stockpile segregation and should not be standard practice. Figure 4 highlights a rapidly changing feed size's negative impact on the SAG mill load and feed rate. The mill rapidly overloads as the mill breakage rates decrease with an increasing feed percentage of coarse material. Rapid overloading is likely to occur when dozing.

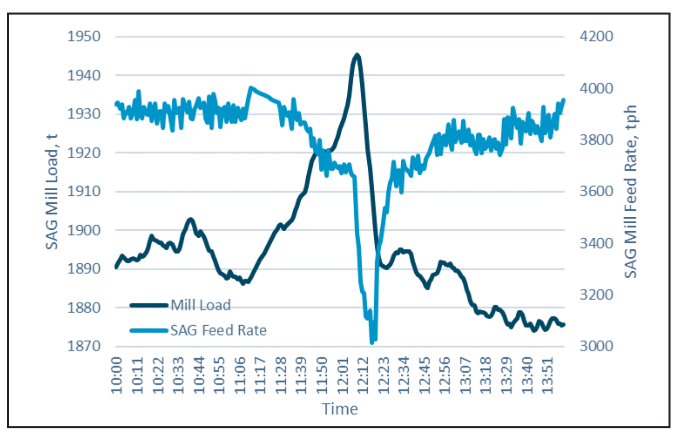

Figure 4. Impact of coarse material on SAG feed rate

- Pebble crusher product control

  There are two considerations to SAG mill stability when operating recycle pebble crushers, the closed side setting (CSS) of the recycle pebble crusher and the recycle rate back to the SAG mill.

  Failing to maintain a CSS, at or below the SAG mill trommel or discharge screen aperture will result in a build-up of critically sized material in the SAG mill. Critically sized material is typically 25–50 mm and is too small for effective impact breakage and too large for attrition. The presence of critically sized reduces the ability to feed fresh material to the SAG mill [12].

  Intermittently operating a recycle pebble crusher, resulting in abruptly fluctuating recycle rates to the SAG mill decreases mill stability and throughput [13]. The impact of the on-off operation of the pebble crushers is exacerbated when the CSS is not tightly controlled.

- Changes in the ore density

  A change in the ore-specific gravity can impact the ability to control the SAG mill discharge density. Water addition is typically controlled by milled tonnes, so transitions between low and high SG ores can cause disturbances in the mill load, as seen at Phu Kham [8]. Phu Kham installed a bulk volumetric sensor on the SAG mill feed conveyor just before the feed weightometer to infer the online ore density measurement. This information was used to control SAG mill water addition by volume, instead of mill tonnes to maintain optimum slurry density.

Solution—Operating Load Setpoint

The first step to optimizing SAG mill performance is determining the optimal operating parameters for the mill, particularly mill filling. The performance of the SAG mill is very sensitive to the mill filling, which influences throughput, power draw and grind size [4]. The objective of the control strategy in most operations should be to maintain the optimum mill filling for the given ore properties over the entire life of the mill liners.

How to determine SAG mill performance curves:

- **Step 1: Crash stop and grind out the mill**

  Crash stop the SAG mill by abruptly cutting the feed rate, mill power and water addition during stable operation, typically by tripping the feed conveyor pull cord.

  Measure the mill filling level by pulling the feed chute and counting the exposed lifters, measuring the chord length, and measuring the height of the charge. Molycop provides simple tools to conduct these measurements [7]. To develop a good relationship, at least two different mill filling levels should be measured plus the ball charge [4].

  The rock charge is then carefully ground out until just the ball charge remains. The ball charge is then measured in a similar fashion. The three data points can be used to determine the relationship between mill load and mill filling.

  Due to liner wear, this procedure should be conducted with new and worn liners to develop the relationship over the life of the liners.

- **Step 2: Collect power vs mill filling data**

  Operate the SAG mill at a range of mill fillings and mill speeds. The range of mill fillings is typically between 20–40 %v/v but should be adjusted based on each operation not to exceed the SAG mill operating or structural limits. Mill speeds should be in the range of 60–75 % critical. Mill speed should be limited to not cause direct shell impacts.

  The mill should be stabilized at multiple intervals within the mill filling and mill speed ranges, by adjusting the mill feed rate. After a minimum of 30 minutes of stable operation, a discharge sample should be taken to determine product size distribution.

  Determine the average power draw and feed rate for each mill filling and mill speed interval.

- **Step 3: Construct the performance curves**

  Plot mill power draw, feed rate and grind size against mill filling for each mill speed interval. The performance curves can be used to determine the optimal mill filling based on throughput and grind size targets.

  Performance curves can be developed for major ore types to develop operating strategies for ore variability.

An example of a performance curve is shown in Figure 5.

A similar performance curve, constructed with the same methodology, can determine the optimal SAG mill operating density for a given ore type. A throughput peak will present itself within an ideal mill density range for given mill speed. Maintaining this density, typically in the 70–78 %w/w range, can reduce the likelihood of slurry pooling due to excessive mill dilution and increase the breakage efficiency.

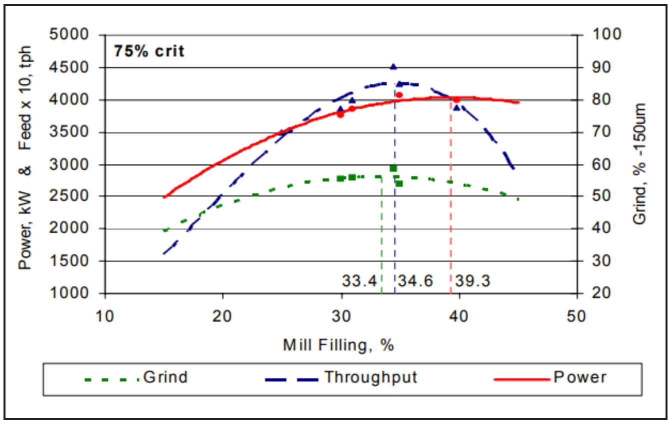

Figure 5. SAG mill performance curves [4]

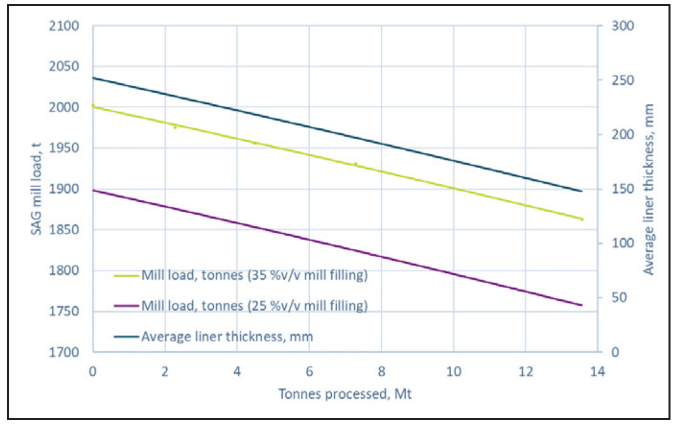

Figure 6. SAG mill load model

Once the optimal mill filling has been determined, it is important to maintain this parameter as the mill liners wear. A SAG mill load model can be developed to determine the optimal mill load setpoint for the operators based on the cumulative tonnes processed on the installed mill liners.

How to maintain optimal mill filling:

- **Step 1: Mill load vs mill filling**
  Since mill filling is not a typical parameter available to mill operators, a relationship with mill load needs to be developed. Crash stop and grind-out measurements with liner wear data can be used to determine mill filling at an average liner thickness. A relationship is then developed between mill load and mill filling as a function of average liner thickness.
- **Step 2: Develop a mill load model**
  To achieve the required mill filling, the mill load model can then be plotted against the cumulative tonnes processed on the current liner set. This guides the operator (or control system) to achieve target mill filling.
  An example of a SAG mill load model is shown in Figure 6.
- **Step 3: Continuous validation**
  Routine crash stops, and grind outs should be conducted in conjunction with liner wear measurements to continuously validate and update the SAG mill load model.

Since it is not always practical to crash-stop the mill due to lost production or safety concerns, a practical solution is to install a mill-filling measurement device (Kaltech Sentinel [14]). If the model is well calibrated, a deviation from the calibration curve can indicate that the media level is off target.

Process Control

Challenge—Recommending the Correct Control Solution

The primary control objective is maintaining a stable mill load and maximizing throughput for variable ore competency, feed size distribution, and operating conditions [1]. Causes of poor controller setup include:

- Over-reactive control response, either too large, too frequent of changes, exacerbating mill load fluctuations because of poorly tuned control system or an overly zealous control room operator
- Poor understanding of response times and the lag between the control system change and the response in mill performance resulting in cyclic control.
- Sensors and instrumentation that is not functioning or poorly calibrated.
- Lack of operator confidence in the control system or inadequate operator training in the appropriate control response.

An example of over-reactive control response to changing mill load and a properly tuned response is shown in Figure 7. Figure 7a shows a highly fluctuating mill load because of large changes in the SAG mill feed rate setpoint.

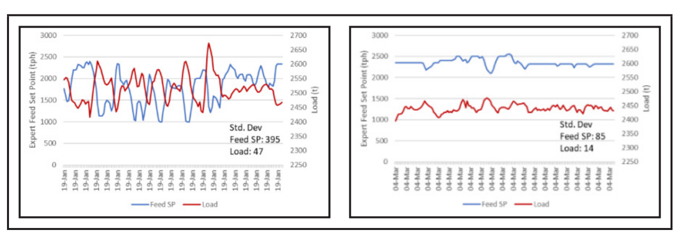

Figure 7. Over-reactive feed rate control (a); tuned feed rate control (b) [11]

Solution—Process Control Strategies

Now that the optimal mill filling has been determined and a SAG mill load model has been developed to know what the mill load should be for the life of the liners, the process control strategy needs to be developed and tuned to maintain that mill filling.

A well-tuned comminution circuit process control aims to maintain circuit stability and comminution efficiency with highly variable conditions such as ore competency, feed size, feed rates and ore specific gravity [1].

The following steps to setup an effective comminution circuit controller was described by Chandramohan et al [1]:

- **Step 1: Understanding the ore source**
  Geometallurgy is a valuable tool that can define the changing ore properties over the LOM and the impact on the comminution circuit performance.
- **Step 2: Understand the feed size distribution impact on the performance of each comminution device**
  Once the ore source has been defined in the mine plan schedule, each comminution device's feed size distribution range should be assessed providing insight into potential mechanical changes required to maintain a stable mill load i.e., grate aperture and grate open area.
- **Step 3: Start with a basic controller—review the complexity**
  The base layer of control uses experienced operators to set operating setpoints and limits. Several focusing questions should be asked to determine the requirement for fuzzy, MPC or Adaptive controllers such as, is the ore highly variable hourly? Can the operator achieve stability? Are the operators adequately trained?
- **Step 4: Develop an implementation road map for the Life of Mine**
  For brownfield operations, a roadmap should be developed to assess the level of operator training required, reviewing the circuit performance, and then consider process optimization and operator training to achieve the required targets. Once optimized, then consider advanced controllers to increase circuit performance and minimize operator input.

For an effective process control for a SAG mill treating highly variable feed, requires working instrumentation, correct tuning of the process control and knowledge of the process and operation of the equipment. In summary:

- **Instrumentation**
  The instrumentation installed on a SAG mill is integral to control [1]. Instrumentation should be routinely calibrated and replaced if faulty.

  Maintaining a stable mill load depends on accurately measuring mill dilution via flow meters and belt scales. An example of poorly regulated mill dilution due to faulty instrumentation is shown in Figure 8. Figure 8 shows a significant decrease in SAG mill power draw, at constant mill speed and mill load, due to slurry pooling when an unmetered source of water was added to the mill feed to compensate for scaling of the main water addition line. The addition of this unmetered water hampered the operator's ability to know and control the density inside the mill.

  SAG mill microphones and vibration sensors are essential in providing information for optimizing SAG mill control. A fundamental application of this instrumentation is to prevent grinding media from impacting the shell liners, either due to running the mill at an excessively high speed relative to the lifter profile or maintaining a mill filling that is too low.

  Phu Kham is an excellent example of employing instrumentation to manage variable feed, in this case, specific gravity. Mill dilution is controlled by an inferred specific gravity determined by measuring the volume of material on the feed belt [1].
- **Defining the correct tuning**
  There is not a generic control strategy that can implemented across all SAG mills but there is a considerable amount of reusable engineering [15]. SAG mill control manages the mill load to a set point by

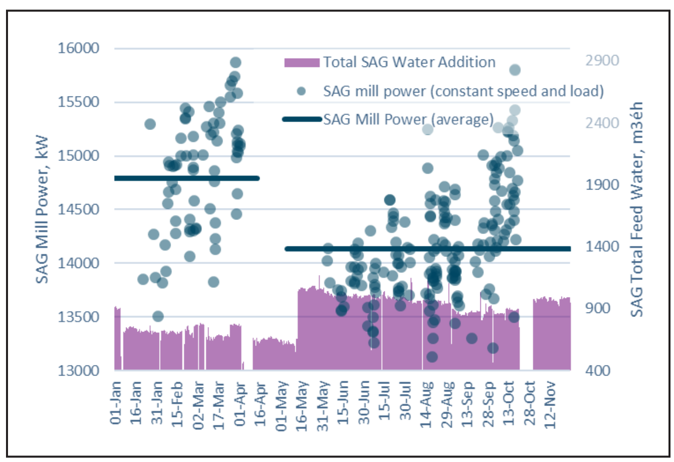

Figure 8. Impact of unmetered density control on SAG mill power draw

manipulating mill speed and feed rate and is constrained by mill power and noise. The correct tuning is a function of the circuit design and the ore characteristics to define the step size and frequency of manipulated variable changes.

- **Operator training**
  The degree of operator experience, training and individual philosophies of plant operation play a role in plant performance [2]. A finely tuned control system is ineffective if the operator does not trust the control system and opts to operate manually.
  Training and experience for the operators is invaluable, while the control system should clearly display relevant data and operating trends, and display a manageable volume of prioritized alarms, to simplify operator interactions.

SAG Mill Liners and Internal Design

Challenge—Suitable Liner Design for the Duty

SAG mill liners are the primary barriers to protect the mill shell from excessive wear and transfer the mill power to the charge by cascading and cateracting [3] and the SAG mill liner design has a large impact on the SAG mill performance in terms of stability and throughput over the life of the liners.

The following challenges need to be addresses to maintain optimum SAG mill load:

- **Not selecting a suitable liner design for the duty**
  Design challenges with the SAG mill liner are often a result of not designing to the required duty, for example, is the liner being designed for extended life or to maximize throughput. This was a challenge faced at Newmont's Penasquito operation, a bi-directional liner with a steep lifter face angle limited the safe operating speed and resulted in below target throughput. The fixed reline schedule and steep lifter design meant at the time of change out the lifters had plenty of lift remaining resulting in excessive steel waste [11].
- **Poor slurry flow through the discharge system**
  Insufficient grate discharge capacity and mill pumping capacity, coupled with low SAG mill slurry densities, can result in slurry pooling. Slurry pooling, the build-up of slurry within the mill that exceeds the height of the charge, results from a slurry inflow rate greater than the discharge capacity of the pulp chamber and grates [3]. An example of slurry pooling is shown in Figure 9.
  – No slurry pooling = inflow flow rate < grate flow capacity < mill pumping capacity
  – Slurry pool = inflow flow rate > grate flow capacity > mill pumping capacity
- **Failure to measure the wear of liners**
  The wear of liners that are not routinely measured and tracked can result in the failure of liners before the reline date or intact liners being thrown away. As previously discussed, not measuring liner wear typically means that the SAG mill load is not compensated in the control system to target the optimal mill filling.

Solution—Designing Mill Internals for the Duty (liners and discharge system)

The following solutions are required for maintaining an optimum SAG mill load:

- **Selecting a suitable liner design for the duty**
  There are two design philosophies when designing the SAG mill liners: designing for liner life and designing for SAG mill throughput [3]. The design philosophy should be married to the requirements for each operation based on performance targets and ore characterization.
  Chandramohan et al. [8] explain that the lifter face angle changes the surface friction component between the charge and lifter, affecting the wear rate, and a steeper lifter prolongs the wear life. If the operation's objective is to maximize throughput, a steeper face is counterproductive as it limits the safe operating mill speed range decreasing the ability to maximize power draw. Figure 10 shows a new lifter design

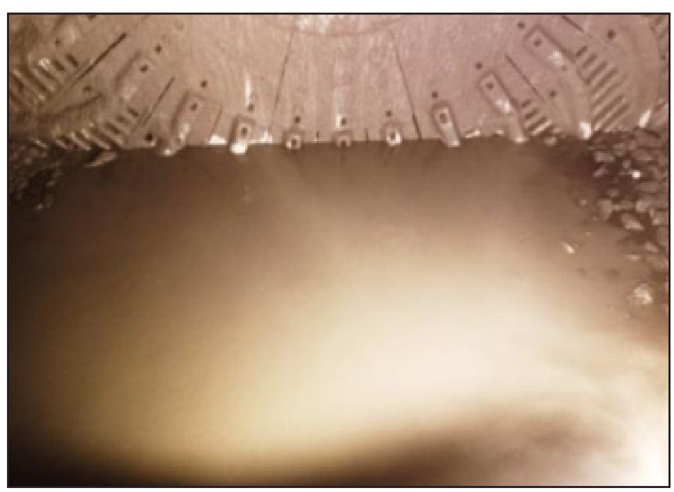

Figure 9. SAG mill slurry pooling

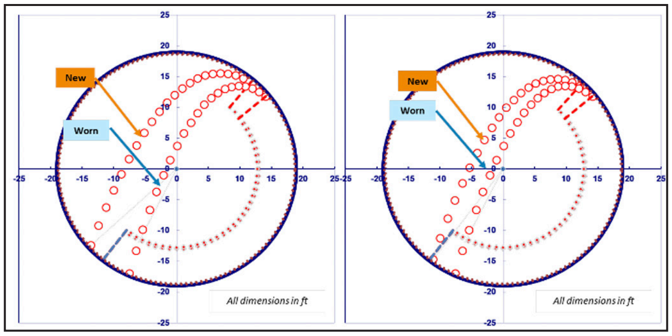

Figure 10. Current (left) and optimized (right) for throughput lifter face angle [11]

that limits mill speed and power draw. An optimized liner design is presented with a shallower lifter face angle allowing a higher mill speed with new liners increasing the breakage rates, thus, throughput is increased [12].

Figure 11 provides an example of a mismatch between liner design and performance objective. The operating data shows the ramp up profile of the installed bi-directional liner design with steep face angles. The red line highlights the potential mill speed ramp up profile to maximize power draw and throughput. An example of bi- and unidirectional liner designs are shown in Figure 12.

- **Grate discharge and pumping capacity**
  Slurry pooling decreases throughput in two ways; due to a decrease in power draw associated with the shift in center of mass and a decrease in energy transferred to the rock due to the cushioning effect of the high slurry level [16]. Large-diameter SAG mills equipped with a radial pulp lifter design are likely to experience incomplete discharge and slurry backflow into the mill. The backflow of slurry can accelerate grate wear and increase the likelihood of slurry pooling. The general strategy to increase flow through the discharge system, described by Chandramohan et al [3], is as follows:
  - The mill speed dictates the flow rate through the discharge grates and pumping chamber. Higher mill speeds decrease the flow through the grates due to a reduction in effective open area and increases the flow through the pumping chamber. To increase flow, decrease the SAG mill speed, increase the slurry density and/or increase the mill filling.
  - Physical design changes to the discharge system are required for highly constrained slurry flow. Increasing the grate open area and converting from radial to curved pulp lifters increases the slurry discharge rate.

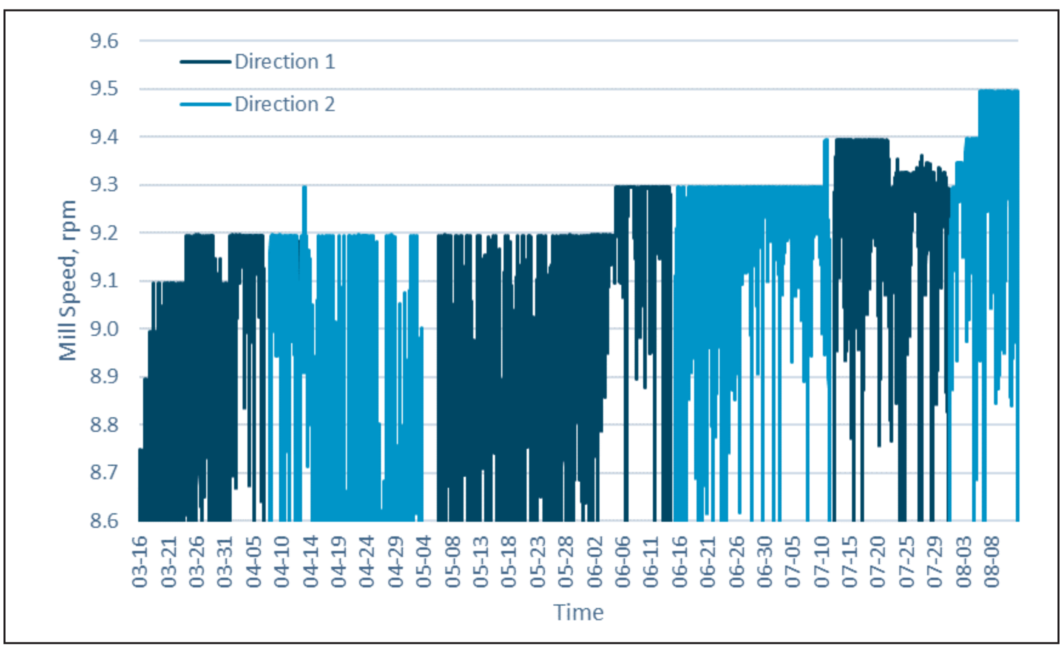

Figure 11. Increased potential of a unidirectional liner design

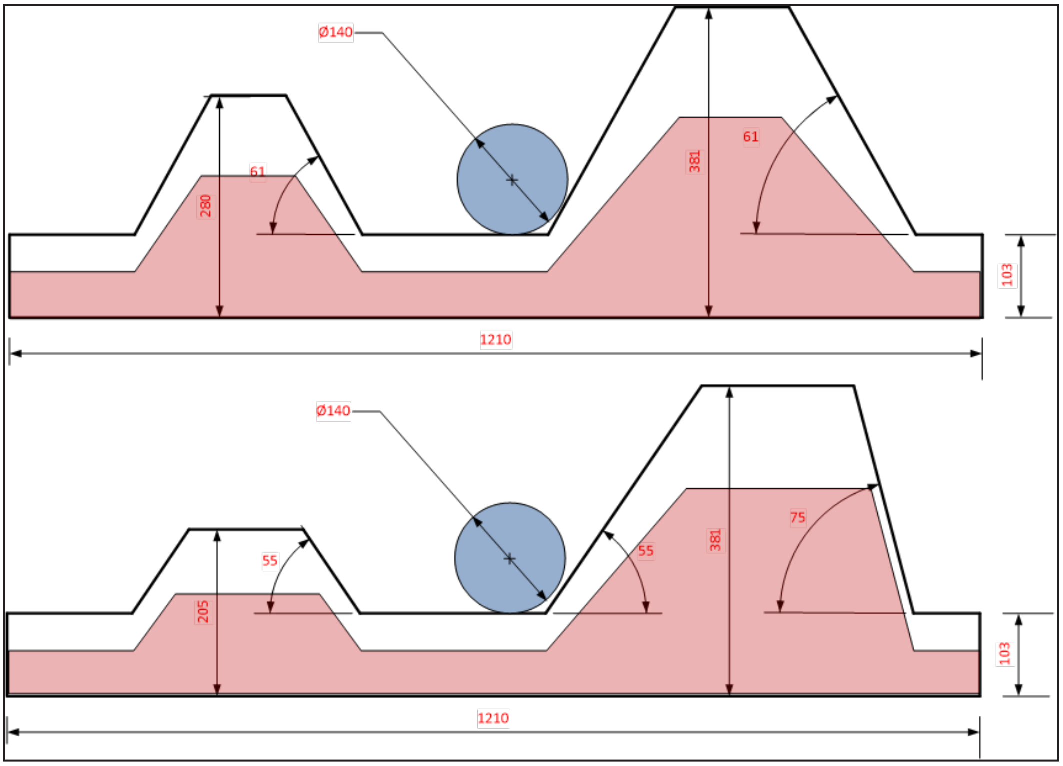

Figure 12. Example of a bi-(top) and unidirectional (bottom) shell lifter design [11]

- **Accounting for liner wear**
  "As with most processes, optimization does not come without measurement" [17]. To develop ramp up profiles and previously discussed mill load models, the liner wear must be measured and tracked in detail. The use of 3D scanners and ultrasonic thickness gauge can provide a high level of detail on wear rates and patterns. A pin gauge is a simple tool that allows for quick measurements of the liner profile, shown in Figure 13. Irrespective of the tool used to obtain the measurements, it is critical to be consistent in collecting the data. Powell et al, [17] recommends selecting three rows of liners and taking 5 to 6 profiles along each row is sufficient to track liner wear. Scheduling routine liner inspections during mill maintenance downtime is good practice to ensure sufficient measurements are taken.

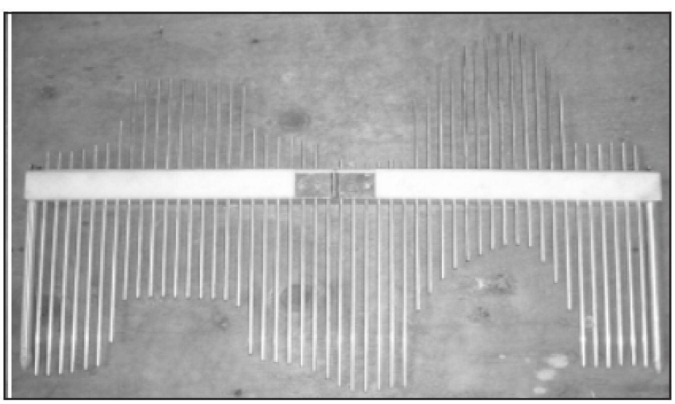

Figure 13. Pin gauge for measuring liner profiles [17]

Grinding Media

Challenge—Poor Quality or Incorrect Composition

Poor-quality grinding media can be a significant source of SAG mill instability. A high degree of fracturing, spalling, and chipping due to high internal stresses, leads to the media being discharged from the mill, making controlling the media addition difficult. Continuous operation at low milling filling levels and high mill speeds can also increase wear rates and fracturing of media.

Incorrect grinding media composition and hardness profiles can lead to media deformation. Deformed media can either pass through the grates prematurely, leading to poor grinding efficiency, or can get lodged into the discharge grate slot reducing the grate capacity and negatively impacting throughput. An example of a deformed SAG mill ball and the resulting blinded grates are shown in Figure 14 and Figure 15.

Figure 14. Deformed grinding media

Figure 15. Deformed grinding media blinding SAG mill discharge grates

Solution—Quality Assurance And Control

Routine inspections of the spent media bunker should be carried out to assess the wear on the media. Misshapen, spalled, or broken media is a sign that the media is of poor quality or the operating conditions inside the mill are not favorable such as a low rock load or operating at too high of a mill speed.

Quality grinding media is critical to maintain stable SAG mill operation. There are often constraints on grinding media such as availability and cost, and to reduce operating costs operations will choose lower quality media from a less reputable vendor. Lower cost media can have some inherent risks like poor quality control in terms of composition and hardness profiles. Routine third party QA/QC testing should be conducted to confirm grinding media meets the operations required specifications. The information can also be used to optimize the media design to reduce wear and breakage.

CONCLUSIONS

In conclusion, this technical paper has provided a comprehensive exploration of the common challenges and optimization strategies for increasing the stability of the SAG mill load. The SAG mill, as the central component of the milling circuit, is often the primary bottleneck for throughput and faces numerous operational challenges that can hinder its load stability and limiting performance. These challenges include feed variability, grinding media and liner wear, instrumentation and control, and liner design. The paper has shed light on the root causes of these challenges and offered practical solutions to enhance SAG mill stability to improve throughput, grind size, and liner life.

The paper emphasizes the importance of understanding and managing factors such as ore variability, primary crusher control, and the operation of recycle pebble crushers. Achieving SAG mill load stability through careful management of control parameters, proper liner wear monitoring, and optimizing liner designs is vital. The role of instrumentation and control systems in maintaining optimal SAG mill operations is also highlighted. Accurate flow meters, microphones, and vibration sensors are essential tools that should not be overlooked. The implementation of these strategies and insights can lead to significant improvements in SAG mill performance.

In summary, this paper serves as a valuable resource for mill operators and professionals in the mining industry, offering a detailed overview of the challenges faced in SAG mill operations and providing a roadmap for optimizing SAG mill performance. By addressing the issues and implementing the recommended strategies, operators can enhance the stability, efficiency, and longevity of SAG mills, ultimately improving the overall milling circuit's productivity and profitability.

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New Life for the Veragold Mine—Low Risk Tailings Storage

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ABSTRACT

The Mina Santa Rosa mine in Panama was the victim of a mine closure 24 years ago that left the community in dire straits. The mine showed the potential resources of greater than 1M ounces of gold and 4.5M ounces of silver. Veragold Mining Company decided to reopen the mine and address all the issues that were involved in the startup of an historic mine. This paper provides methods to restore the community trust, provide a transparent process, and develop an environmentally sound flowsheet. Immense scrutiny surrounded the Tailings Storage Facility, and the company developed a plan focused on paste thickening and surface stacking to eliminate the need for a conventional tailings' facility. Paste thickener principles and benefits are also provided.

INTRODUCTION

In early 2000, the town of Cañazas in the Veraguas Province of Panama lived an experience not uncommon to mining communities whenever depressed markets or technical failures result in the premature closure of a mine and the departure of a foreign company. In the aftermath of unkept promises, unmet payrolls, limited economic opportunities, and environmental legacies of an abandoned mine at their doorstep, the prospect of reopening the mine understandably agitated old wounds and rekindled community divisions. After riots ensued, fires were set, and mine infrastructure was destroyed, and with memories of past cyanide spills still lingering, fears of history repeating itself understandably resurfaced. When the new owners acquired the property a decade later, the community was naturally suspicious. Public statements by the Mayor of Cañazas in 2012 acknowledged that although some sectors of the district supported mining development, local authorities were not universally supportive of resuming mining activity in the area. It is against this backdrop that Veragold Mining Company has worked over the last decade to reopen a brownfield project. Through ongoing dialogues with the community, the company has sought to understand the needs, desires, and fears of its stakeholders, and has allowed each interchange of ideas to reshape the Mina Santa Rosa project.

HISTORY

Located adjacent to the town of Canazas, Panama, 300 km from Panama City, resides the Minas Santa Rosa project that operated under the previous owner Greenstone Resources, Ltd. They operated an open pit-heap leach facility from mid-1996 through August 1999 and produced 100,007 oz of gold. Heavy rainfall in 1997 and 1998 caused operational problems and diluted the pregnant leach solution. The Minas Santa Rosa operation was put into care and