SUPPLY, INSTALLATION, & COMMISSIONING OF THE WORLD'S LARGEST GRINDING MILL

by

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ABSTRACT

In June 1998, the world's largest grinding mill, the 40 ft (12.2 m) diameter 20 MW Cadia gearless SAG mill, was commissioned. This was a leap of over 40% above the largest operating SAG mill. A significant saving in capital cost gave the incentive necessary for a single mill line at Cadia, resulting in the selection of the 40 ft (12.2 m) diameter mill. Now, after 18 months of operation, this paper will review the significant items involved in the development, design, manufacture, installation, and operation of this mill.

INTRODUCTION

Summary Description of the Cadia Project

The Cadia Hill Mine is located 25 km southwest of Orange, in the Central Tablelands of New South Wales, Australia. The Mining Lease covers approximately 3100 hectares of the Cadia Valley. The Cadia deposit is a large, homogeneous, low grade, porphyry-type gold-copper resource. Currently, a reserve of 202 million tonnes (grading 0.73 g/t gold and 0.17% copper), containing 4.7 million ounces of gold and 347 000 tonnes of copper, has been defined.

The operation consists of open pit mining and ore processing to produce gold bullion and a gold/copper concentrate. The operation processes 17 million tonnes per annum of ore to produce 91 000 t/a of concentrate and 293 000 ounces of gold per annum.

The plant operates two 12-hour shifts per day and had a targeted availability of 94%.

The plant facilities includes a copper concentrator, extensive water supply system, open pit mine, tailings pipeline and dam, and a concentrate pipeline and de-watering facility located in the town of Blayney, approximately 35 km from the concentrator.

Significant features of the process plant include a primary crusher and stockpile, a reclaim conveyor system feeding a 40 ft (12.2 m) diameter SAG mill (FIGS. 1 & 2), and two 22 ft (6.7 m) diameter ball mills (FIG. 3). A portion of the gold is extracted in a gravity circuit, with the balance of the gold being extracted with the copper in the flotation section of the plant. Concentrate is thickened and piped approximately 35 km to the filter plant and rail load-out facility located in Blayney. Tailings are pumped to a tailings dam, and process water is reclaimed from the tailings dam.

The water system is designed to control and capture available runoff from local creeks, and to store these waters in dams and weirs. In addition, a major portion of the water for the process plant is treated effluent from the city of Orange, and a smaller portion from Blayney.

Power is supplied by a purposely built 132 kv overhead line from Orange.

Mill Selection

The low-grade ore posed a considerable dilemma for Cadia. To achieve a satisfactory economic operation, large scale processing was required. The selection of the mills, equal to the largest designed and operated at the time, gave a plant configuration consisting of two 36 ft x 19 ft (11.1 m x 5.8 m) SAG mills and three 20 ft x 30 ft (6.1 m x 9.1 m) ball mills. This configuration did not provide the most satisfactory economic model for the project. A review of the single line configuration indicated that a significant reduction in the overall capital cost of the plant could be achieved by increasing the size of the mills and reducing the quantity. Increasing the size of the mills, however, meant that Cadia would need to use mills of unproven design {40 ft x 20 ft (12.2 m x 6.1 m) SAG mill and 22 ft x 33.5 ft (6.7 m x 10.2 m) ball mills}. There was considerable concern about taking this step, as many saw this as a risky option in the Cadia Feasibility Study performed by Fluor Daniel-Davy. As a result of the level of concern, much investigation went into the selection of the mills before a final decision on the mill size and configuration was made. The risk analysis considered the following aspects: design risk, manufacturing risk, logistical risk, operating risk, and maintenance risk. This analysis involved a review of the rotating structure, the bearing and lubrication system, the motor, drive, electrical and control system, the lining system, the foundation system, and ancillary systems such as screens, feeders, etc.

The comminution testwork program involved extensive laboratory and pilot plant campaigns. The pilot plant testwork assessed both autogenous grinding (AG) and semi-autogenous grinding (SAG). These pilot plant campaigns were done in conjunction with comprehensive comminution circuit simulations performed at the Julius Kruttschnitt Mineral Research Centre (JKMRC), Brisbane, Australia.

A number of circuit simulations were performed, including 36 ft (11.1 m), 38 ft (11.6 m), and 40 ft (12.2 m) diameter mills. The simulation results suggested that the 36 ft (11.1 m) mill would treat ore at a rate slightly lower than the required 17 t/a. The 38 ft (11.6 m) and 40 ft (12.2 m) mill options were simulated as achieving the target treatment rate; however, the 38 ft (11.6 m) mill required a higher ball charge (10%). The pilot plant testing had indicated that operating and circuit stability difficulties occur at higher ball charges. The 40 ft (12.2 m) option was then considered the better choice as it would allow both better circuit stability and the flexibility to increase the ball charge.

FIGURE 1.   Cadia Milling Circuit

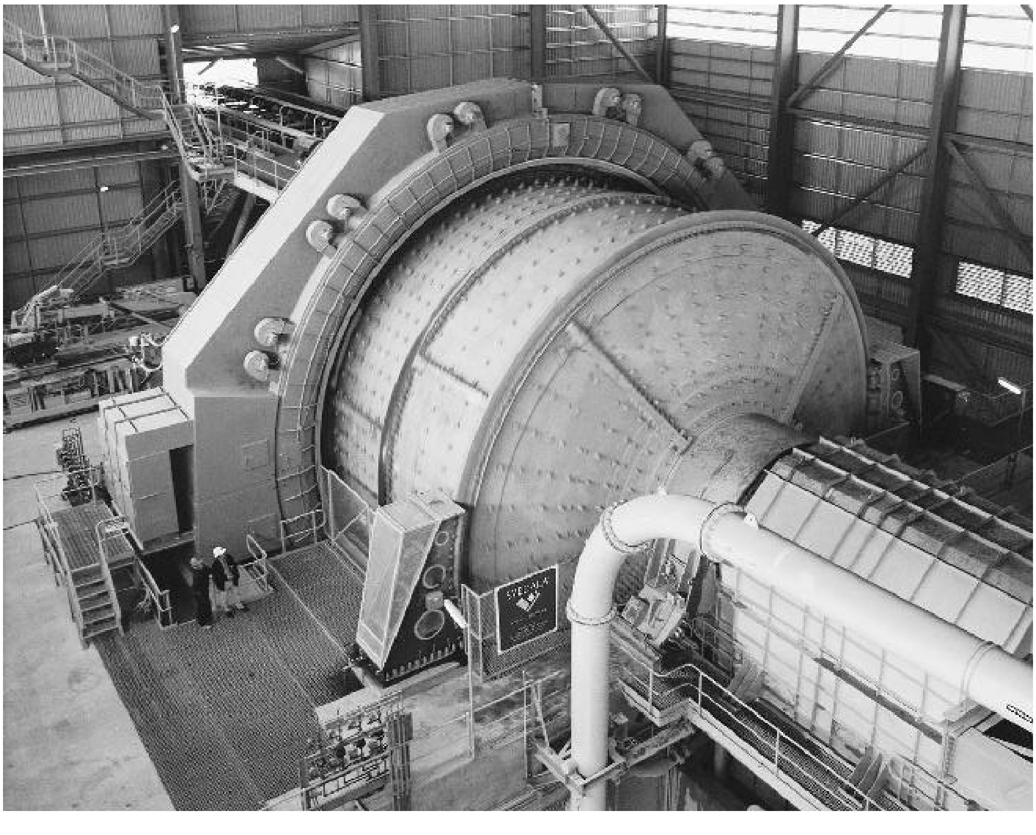

FIGURE 2.   40 ft (12.2 m) diameter Svedala SAG Mill

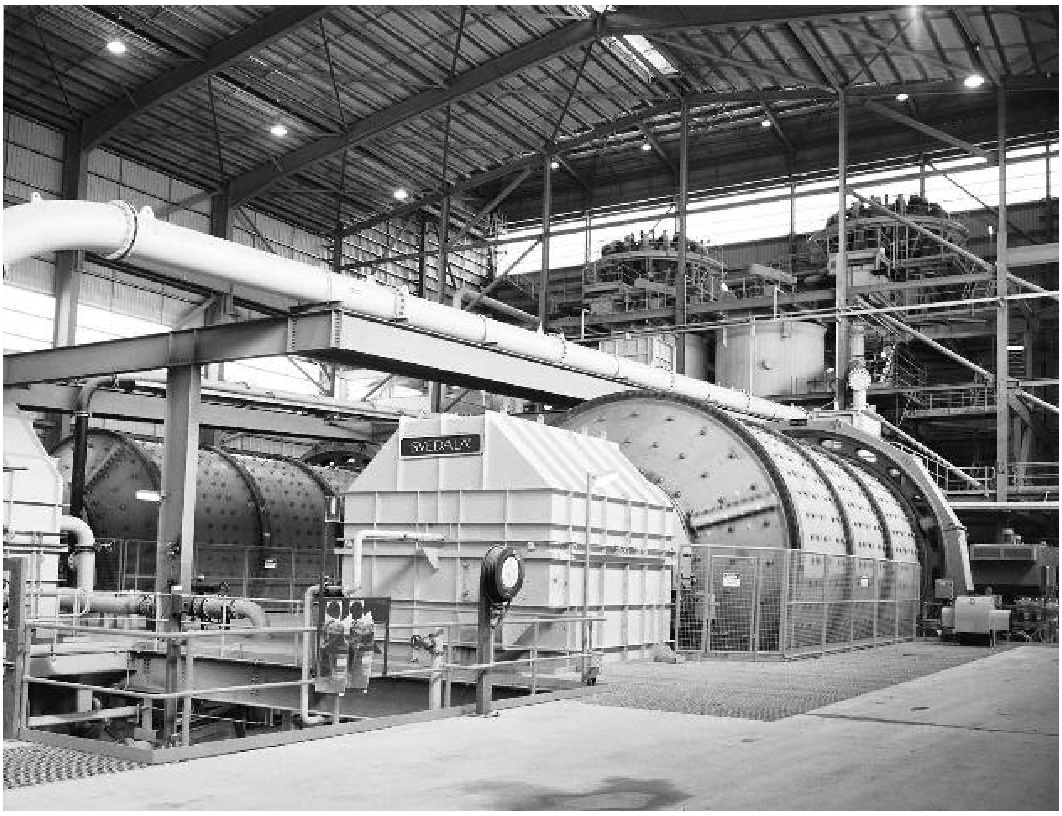

FIGURE 3. Two 22 ft (6.7 m) diameter Svedala Ball Mills

A simulation was also run using AG/PC options. These simulations indicated that a 44 ft (13.4 m) AG mill would also achieve the targeted treatment rate. It was felt that a mill of this size was even more in the realm of the unknown than the 40 ft (12.2 m) SAG mill option.

Reliability and Other Technical Considerations

Design risks: Mills have been built and operated for over 100 years. Large mills have been operating for three decades, yet many people still perceive that there are significant risks associated with the design of these items of equipment including process design and structural/ mechanical design.

In regard to process design, the main concern lies in the scale-up of the mill sizing, especially in regard to scale-up from small scale pilot plant testing and laboratory testing. While these tests have proved to be reasonably accurate in the past, there is a concern as to the existence of an apparent limit to which the model is applicable. Similarly, the effects of scale-up on the design of lifter/ liner assemblies seem to bear little resemblance to the effects obtained in the pilot plant tests.

Structural design: In 1979, Roloff [1] made the statement, "No longer could a simplistic extrapolation be made without an in depth review of the design mathematical model, actual field stresses and, very importantly, the materials of construction and manufacturing process." This statement still reflects the situation today. On face value, the mathematical model used in the FEA of the mill structure would appear not to be affected by the scale-up of mill size. The less obvious impact of mill size increase is the associated increase in material size and hence the potential variance in material properties. It is well known that the yield strength of steel varies as a function of steel thickness. The homogeneity of steel plates and castings of thicknesses exceeding 12 in. (30.48 cm) is not well known, yet homogeneity is assumed in the FEA model. This aspect of the mill design and selection was considered as a significant risk to the project.

Due to the ever-increasing size of the mill components, fewer practical solutions are available to the mill designer. For example, mills of 20 MW have few drive options. Gear/pinion drives of this size are unknown as the physical size of the gear exceeds current manufacturing limitations. Questions as to the practical limitations of the design methodologies must also be asked.

While gearless drives have also been used on mill applications for over 30 years, and recently on most large, high-powered mills, there are still questions as to the continuing scale-up of the design criteria and the design assumptions.

Manufacturing risks: The increase of mill size naturally requires the increase in the size of the individual components. With each incremental increase in mill size, the number of shops capable of manufacturing the components diminishes dramatically. This reduction in number of available facilities is the first manufacturing risk to be considered. If only a few facilities are available, any difficulties experienced with shop equipment means that major delays might be experienced in the production program (e.g., failure of rolls at Mecanica Pesada during Cadia mill fabrication).

DESIGN AND MANUFACTURE

The size of the grinding mill, within specific step limits, influences both the design concepts and manufacturing methods. Most of the influences are due to component weight or mass.

Design Concepts vs. Size for the Cadia Mill

In order to properly design structural pieces for long fatigue life, the existence of material flaws must be considered. No material is perfect, and as thickness (mass) increases, the manufacturing processes will introduce different sizes and types of flaws. This is similarly true for plate, casting, or forging materials. Since we cannot remove all flaws, it is important to determine which flaws are detrimental and which are insignificant. This is all the more important, since, in removing the insignificant flaws, the structure can actually be rendered less reliable and/or very expensive by the "repair" procedures. So, in following this path, not only do we waste money but we also could buy a *lesser* product for the extra money. The methods for striking a technically proper balance are called "fitness-for-purpose," and are used in many industries [2, 3].

Another item to consider is that volumetric inspection techniques might become less accurate with an increase in piece size. Many techniques have calibration procedures which keep the accuracy constant with increasing piece size, but some need adjustment. This is a special consideration for conditions under which a thicker piece might also become more notch sensitive [4].

In the specific case of the Cadia 40 ft (12.2 m) SAG shell, it was felt that the cylinder plate thickness warranted the extra step of normalization to improve notch sensitivity in critical areas. Thus, it was purchased normalized. The weld finishes were also dressed to eliminate any physical notches, and the toes were ground to remove metallurgically-induced notches. (Special grinding procedures were used to minimize the potential for material damage, and the contours were specified to blend smoothly in all areas.) The ground surfaces were then sandblasted to remove any directionality bias which might come from grinding. All of these procedures were introduced to make sure that the grinding was carefully controlled and, in the process of removing physical notches, did not substitute undesirable "burn" characteristics.

Gearless Design Concepts

Gearless mills do not require major complications in design. The unique drive must include the following design considerations:

1. The rotor-stator interaction must be passed to the mill design loads, including an unbalance condition. This condition introduces a load in a variable direction which must be included in mill structure and bearing design.

2. The concept of controlling the rotor-stator air gap produces requirements of displacement control on the mill/rotor structure, and on the stator structure.

3. When considering accident conditions, such as an earthquake, it is prudent to consider a number of possible conditions, both electrical and mechanical. For example, how will an earthquake cause the motor to trip, or, is it wise to assume that an earthquake will never occur during a maintenance cycle that sees one bearing pad removed, etc.?

4. Maintenance procedures in handling liner bolts around the motor mounting area have to be considered, as well as potential leakage effects on the motor. This dictates motor seal designs.

Cadia Fabrication History

Several surprises occurred during the fabrication of the Cadia mill pieces.

1. The mill shell construction required contoured end flanges, and these were manufactured from very thick (318 mm) plate. The shell was fabricated in Brazil, and there were only two local sources (no longer in existence) for such heavy plate. Plate of this thickness was limited in length/width, and Svedala was only able to get three flange strips per delivered plate, due to elimination of large sections as being associated with "top of the ingot" imperfections. Despite such measures, two plate strips, from different plates, were found to have some minor imperfections during magnetic particle (MT) inspection after welding, and during machining. The plates had *all* passed contract

specification ultrasonics, and a further check (UT) to Svedala standards (several orders of magnitude more stringent). They were well within the most stringent plate scanning criteria specified by ASTM. Thus, it was argued that such indications may well be expected to exist in many of the steel structures built around the world using AWS/ASTM standards. However, since the imperfections were visible by MT, the designer was asked to provide further assurances of their insignificant nature. This problem was finally solved to all engineers' technical satisfaction by taking treppan samples out of the affected plate area and subjecting them to fatigue testing simulating 25-year mill life. When *no* specimens failed in *any* test at load levels up to 138% of design conditions, acceptance was achieved. This kind of testing eliminated all theoretical speculations or extrapolations. Subsequent strain gauging in this area, of the operating mill shell, showed some analytical *over*-prediction of running stresses, and thus an *even larger* safety margin in the testing program.

2. The head castings were initially cast with plans to follow original procedures used for 34 ft (10.4 m) and 36 ft (11 m) mills, which involved no machining on the interior cones, no specification being to the contrary. This method has been used on a number of larger mills, some presently operating over 20 years. However, when the castings were inspected, some areas were found to contain thick dross (up to 25 mm). While previous castings had been used with dross up to 12 to 15 mm thick, this was a clear increase. Despite a testing and research project on the strength characteristics and notch sensitivity of dross layers, at a nearby German research institute [5], Newcrest inspection insisted that dross cannot be tolerated, previous experience notwithstanding. This decision required two head castings to be repoured, and the cone inner surfaces to be machined, thus adding to delivery delays.

3. The machining of the inner conical surface revealed another consideration with the castings. By contract specification, these ductile iron castings were to be oven stress-relieved. While this is a necessary step with gray iron castings, most grinding mill ductile iron castings, which solidify differently, are control cooled in the mold, slowly, as to not generate significant residual stress. When oven stress-relief was performed on these large, heavy castings, the foundry's careful dimensional control was lost, in some minor bowing and distortion, in the oven. This, when combined with the natural weight distortion when the casting segments are placed on the vertical machining center, and the possible steps between casting segments, made flaw locations questionable. Australian specifications call for casting examination by UT to be done only in the machined state. While this makes sense as an acceptance criteria, it is an extremely risky situation for both the mill designer and the mine owner. If a machined head segment is found unacceptably flawed, it is a difficult situation from which to recover, in schedule and cost. It is decidedly not simple to remake a single machined segment. Therefore, the casting process went forward in the following steps:

   a. Inspect the heat-treated cast segment for flaws. Establish flaw maps through the thickness, and in area. Establish that the segment is acceptable for machining.

   b. Assemble four acceptable segments on the vertical machining center, recalculate machining allowances for each segment as an integral portion of the whole 360° head. Recalculate flaw criticality through the "new" thickness; i.e., now the real projected, finished thickness, including allowances for distortions and inter-segment fit.

   c. Make the first machine cuts, and recheck for any omissions/corrections to the previous step.

Svedala, with a long history of similar experience with gray iron castings, had little problem with the necessary steps. However, close, step-by-step interaction between the machine shop and the design engineers is necessary.

Lessons for the Future

The problems encountered with Cadia manufacture relate directly to the "fitness-for-purpose" concept touched on earlier in this section. Ignoring this concept can literally cost the mining equipment purchaser millions of dollars in fruitless pursuit of theoretical perfection and the directly related start-up delays. One example related to Cadia manufacture is shown in FIGURES 4a & 4b. FIGURE 4a shows a cut up cross-section of one flaw area in a casting that was rejected for dross, and then later used for iron ultrasonics research. The small, dispersed, microshrink flaws are noticeable therein. FIGURE 4b shows, in dashed lines, the crack cross-section that the equipment specifications make the designer consider as the equivalent flaw, whose criticality he must evaluate using, further, a material properly given in the specification, which itself has close to a 60% safety factor. The unrealistically high safety of this cumulative calculation should be evident. This becomes the most safe area in mill component design. The inability to intelligently modify this when necessary has cost many a mine a delayed start-up over the last 13 years.

Fitness-for-purpose is a concept that applies to people as well as things. In most disciplines, specifications are written by code committees which have personnel directly

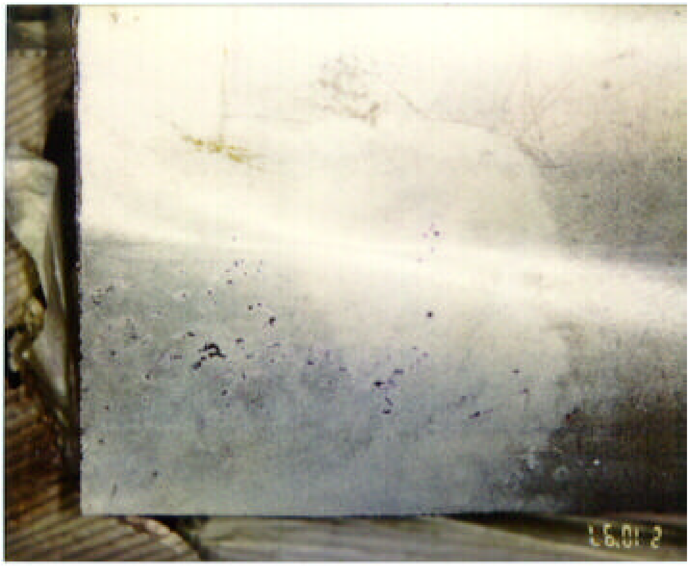

FIGURE 4a. Casting Flaws

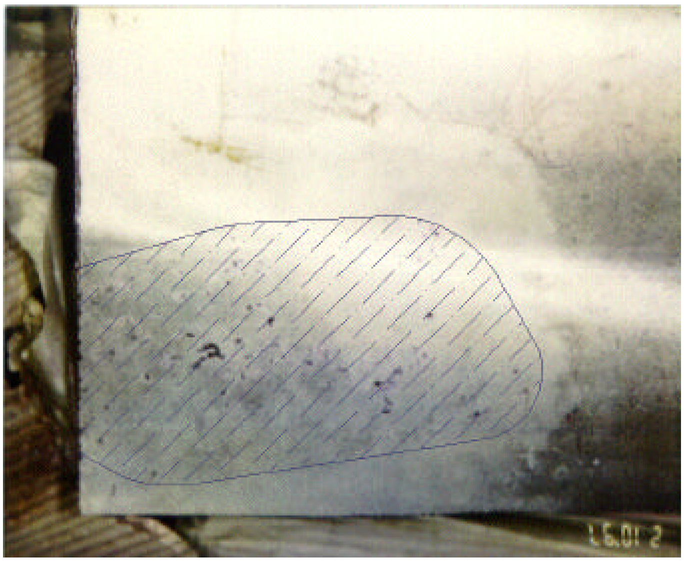

FIGURE 4b. Idealized Crack Cross-section

experienced in the relevant areas, and lots of reference data. Such are the gear design specifications written by AGMA. AWS is very specific about the duties and responsibilities of engineers and inspectors, each based on their area of competence [6]. Only in mill equipment, however, do we follow a specification process, which can only be described as "each to his own" without regard to experience, history, or specific expertise. An "International Association of Mill Designers" is long overdue, and could save mines countless dollars in equipment purchasing and start-up [7].

INSTALLATION AND START-UP

Due to careful pre-planning, mill installation went very well. The major problem concerned the SAG mill structural bolts. These bolts were to be installed using ultrasonic length/stretch measuring techniques for each bolt. During the initial length check, it was found that a few of the bolts were difficult to gauge due to signal "instability." When one of these bolts was sectioned, see FIGURE 5, a discontinuous, crack-like flaw was found in the bolt head. This initiated a more detailed study of the bolts, and resulted in an ultrasonic "screening test" for this flaw. The flaw was initially suspected to be a forging problem related to temperature at time of bolt head forging. Further analysis, after mill erection, however, related the problem to the bolt bar material. This material is ordered, by the bolt manufacturer, per the specification ASTM 322. One of the relevant sections in that specification states:

> "7.1 Workmanship - The bars shall be free of pipe, cracks, and flakes. Within the limits of good manufacturing and inspection practices, the bars shall be free of injurious seams, laps, segregation, or other imperfections which due to their nature, degree or extent, will interfere with the use of the material in manufacturing or fabrication of suitable parts."

However, when the bolts were submitted to *several* testing laboratories in an "after the fact" research program (after replacing these bolts at Cadia), the findings were as follows:

> "The bolt exhibited evidence of cracks that were associated with inherent material defects present in the original hot-rolled bar. The cracks appeared to be associated with moderate-to-heavy segregation, which produced martensite bands at the center location." And, ". . . . were the result of linear crack-like and centerline defects present in the raw bar stock material used to manufacture the bolts."

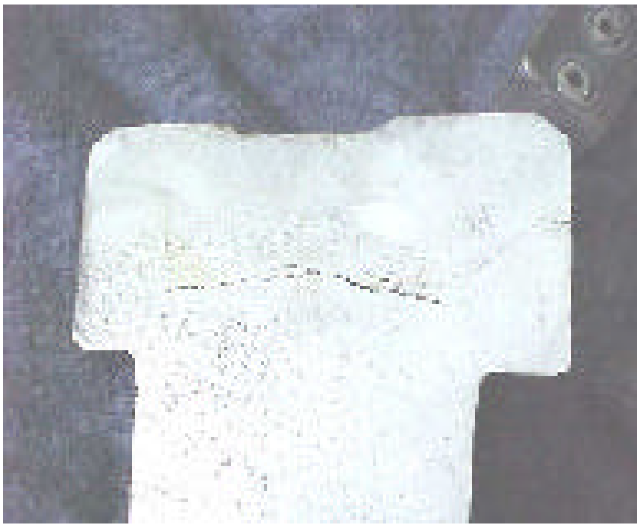

FIGURE 5. Bolt Head Crack

Since these flakes in the bar material appear to be the root problem, a screening procedure is being sought. A bolt UT screening procedure is in place for the effects of forging on these flakes, but that does not present a screening method for studs, etc.

Two other problems that initiated at start-up concerned large ball breakage and stator vibration. The initial charge of 125 mm balls had too high a hardness, which resulted in numerous "half balls" leaving the circuit through the grate slots. This was corrected by ball metallurgy.

The motor stator initiated vibration at approximately a mill speed of 9.7 rpm. The stator structure was stiffened against this vibration by the addition of pedestals at the bottom of the stator. These removed unfavorable vibration characteristics from the total mill operating range. The exact nature of the stator stiffness problem, and preventive means for the future, continue to be under investigation.

MILL PERFORMANCE

Design of this mill went far beyond anything Svedala had previously supplied. Mill sizing was performed by traditional means in that the power draw was scaled from a known Svedala database for operating mills, and an exponential factor of 2.5 was applied to the ratio of the new mill to the existing mill diameter. The ratio of the effective grinding length was scaled directly. The mill diameter used for these calculations is the effective inside liner diameter, calculated considering the lifter bars are "smeared" to provide an average liner thickness. The effective grinding length is the traditional value measured from inside the mill feed cone liner plate to inside the grate plate, not including the lifter bars on the feed end or discharge end. If the lifter bars are uncommonly large, then an adjustment can be made.

Power draw is also dependent on the constitution of the mill feed. The test program provided a bulk weight of the ore that was used for power calculations. The charge density is calculated by using four components: the ball charge, the rock charge, the slurry to fill the voids in the ball charge, and the slurry to fill the voids in the rock charge. It is important to utilize the measured values generated in a pilot test. Measurement of these values has shown that the mill will concentrate the hardest-to-grind fraction of an ore body. This is not typically apparent by measuring the bulk density of an ore type as delivered by the mill feed conveyor. In some cases, ore that makes up 5% of the ore body has been measured as the major component of the mill charge, when the ore charge inside the mill has been sampled.

After mill start-up, it was necessary and important to confirm the actual mill power draw. FIGURE 6 illustrates the result of measurements of the 40 ft (12.2 m) diameter

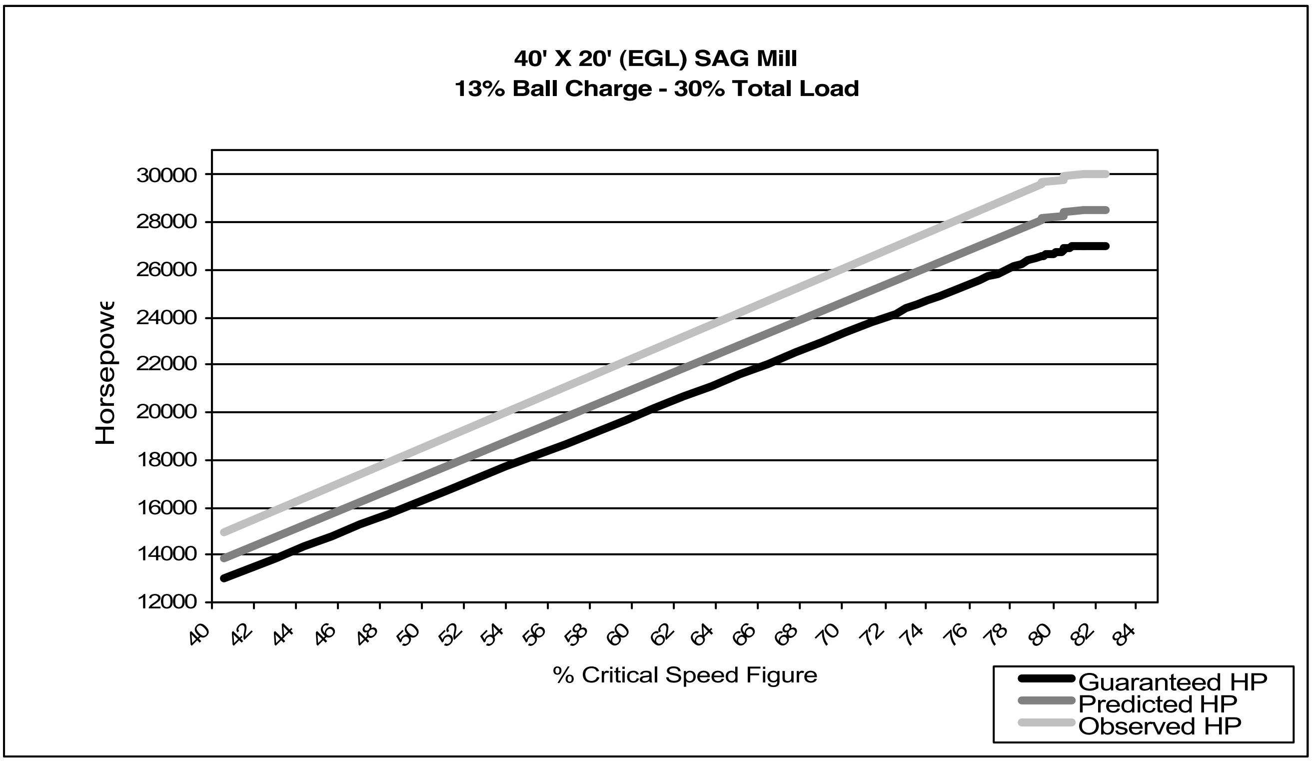

FIGURE 6

mill at Cadia, operating with assumed ore specific gravity and assumed bulk densities. As can be seen from the figures, the expected power draw measurements are very close to those measured. It is important to note that the preferred method of measurement of mill volumes and ball volumes includes the utilization of a surveyor's instrument, located in the mill trunnion, with five sets of measurements of 10 points each (50 total), to arrive at the distance from the mill centerline to the top of the charge. Other methods of charge measurement can be very deceptive and produce results that are often misleading.

FIGURE 7 illustrates the charge level variations observed during the charge measurement program using a surveyor's instrument. Note that the level of the charge varies by almost 0.75 m in vertical height.

It is important to assess the actual mill liner condition and resultant internal mill dimensions at the time of power assessment.

FIGURE 8 illustrates the measurement of power under closely controlled conditions on the 40 ft (12.2 m) diameter Cadia SAG mill. It is interesting to note that the chart, relating power and speed of the mill by the distributed control system, shows that the power required for a point at 74% of critical speed is very close to predicted power draw. It is also interesting to note that when the speed was increased above 74%, the power did not increase as expected normally. The ring motor is designed to perform at constant power above 74% of critical speed. There was a power spike, immediately followed by a traditional, typical control of motor power limit. One opinion is that this was the result of the control system limiting amperes in the ring motor. Ring motors are typically specified as constant torque to a certain design point (in this case, that point was 74% of critical speed). Above this speed, the motor is designed as a constant power motor.

Mill liner design is a complex subject that needs to be thoroughly understood, especially with the very large mills. Mill trajectory programs and the charge motion simulators, and investigations by Rajamani [8-14] and Valderama [15-18], have enabled further refinements in overall mill liner design. It is apparent that the liner design can have a profound effect on the economic performance of the mill. Design primarily affects ball wear rate, liner wear rate, and mill power utilization. Svedala uses the above programs, and McIvor [19] and Powell [20]. Inclination of the angle of the lifter bar results in less impact on the ball charge, with a corresponding decrease in ball breakage and ball consumption.

Svedala has been involved in experiments for many years, and continues to investigate the improvement of liner design and its impact on power draw. A large SAG mill was subjected to a progression of 36 lifts per circle, 24 lifts per circle, and 12 lifts per circle. A value of 24 lifts per circle was selected after this exercise. The lower numbers of lifts per circle were not capable of drawing the power required in an efficient and stable manner.

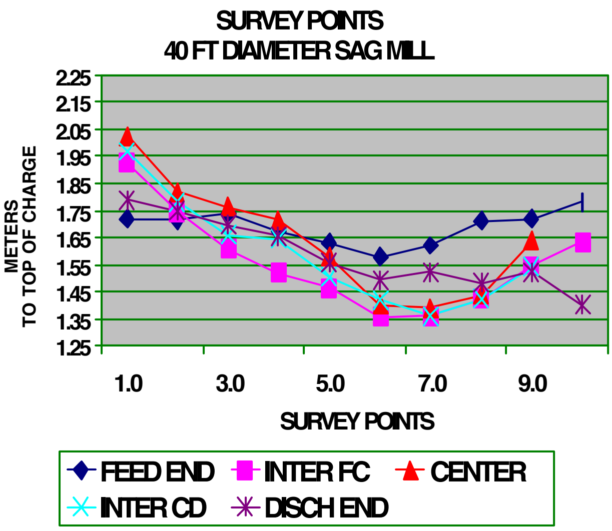

FIGURE 7. Charge Level Variation

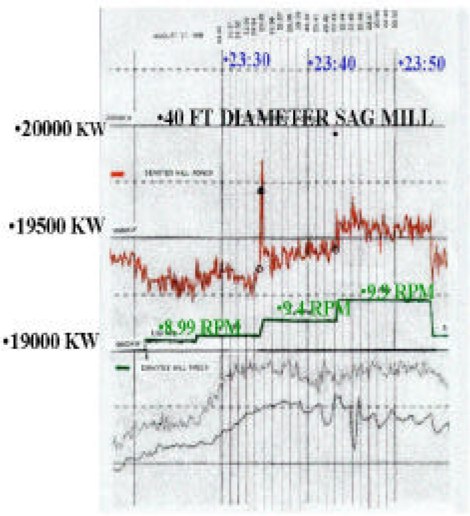

FIGURE 8. Power Measurement Chart

The design of the lifter bars will influence the power curve. Increasing angles on the leading edge of the lifter bar will cause the mill to require a higher speed to obtain the desired mill power level at a given set of conditions of load (measured as percent of mill volume, percent ball charge, percent solids, specific gravity, and bulk density). Ring motors are very flexible, and mill operations can be varied at will. Variable speed drives operating with traditional gear and pinions must be tightly controlled due to the effects on the gear train. Torque values of the gear train will require control of the speed with relation to the motor power draw.

FIGURE 9 illustrates the use of the Rajamani program for a 40 ft (12.2 m) diameter mill operating with a 13% ball charge. The mill is turning at 8.99 rpm (approximately 74% T.C.S.) and has a 12 degree angle on the lifter bar. The mill liner design pattern has a *high/low* design and has 78 rows per circle.

FIGURE 9

FIGURE 10 illustrates the use of the Rajamani program for a 40 ft (12.2 m) diameter mill operating with a 13% ball charge. The mill is turning at 8.99 rpm (approximately 74% T.C.S.) and has a 20 degree angle on the lifter bar. The mill liner design pattern has a *high/low* design and has 78 rows per circle.

FIGURE 10

FIGURE 11 illustrates the use of the Rajamani program for a 40 ft (12.2 m) diameter mill operating with a 13% ball charge. The mill is turning at 8.99 rpm (approximately 74% T.C.S.) and has a 12 degree angle on the lifter bar. The mill liner design pattern has a *high/high* design and has 78 rows per circle.

FIGURE 11

It is apparent from the work done at Cadia that the predicted and actual power measurements are within reasonable tolerances. It is possible to design and operate SAG mills of 40 ft (12.2 m) diameter (and likely larger) with designs based on currently available large mill power data. It is a challenge to accurately gather and assess operating data from any large mill considering that the actual mill and load conditions and actual output power draw of the mill motor must be determined.

Liner Performance

Rubber dischargers: Cadia has experienced accelerated wear of the rubber coated pulp dischargers originally installed in the mill. The first replacements occurred 12 months after mill start-up. There are a number of schools of thought as to the cause of the premature failure of the dischargers. These include the opinion that a material "slug" is trapped in the outer row, moving in the pocket, without being able to be discharged at the present speed of 80% of critical.

The current design borrows from the curved discharger design used in single directional mills and incorporates some curvature in the discharge pockets, creating a rounded scoop at the end of the pulp lifter. Full curved lifter design is not appropriate for the Cadia mill, as it is bi-directional. Changing the mode of operation to single directional is not economic due to the sharply reduced life of the mill lining system.

Trommel panels and their development: Cadia experienced early problems with the rubber trommel panels initially supplied with the SAG mill. These problems were manifested in panel material failures requiring regular replacement of the panels (5 weeks typical). The nature of these failures was described as cutting along the line of the panel supports. The failures have been attributed to the impact of a large quantity of broken ball sections during initial start-up, and the large discharge product size.

A number of modifications to the design were tried, including steel reinforced panels (lateral and longitudinal reinforcement were tried), changes to rubber compound, and elimination of a number of screen holes (resulting in larger inter-hole spacing along the mounting edge). The current design uses snap-in modular panels with special rubber compound to handle wear and strength. This design has increased the life of the trommel panels from 5 weeks to 24 weeks.

FUTURE PLANS

Cadia is undertaking a plant optimization study with the objective of economically increasing plant capacity. There are a number of changes to the grinding circuit being studied by Cadia. Two of these are the speed-up of the ball mills and the extension of the SAG mill trommel. Cadia is considering speeding up the ball mills in an attempt to increase grinding power draw and throughput. This is considered as an appropriate approach to increasing throughput at a similar grind size. The main process issues faced by speeding up the mills are higher impact and wear, with the gain in plant throughput.

The extension of the length of the SAG mill trommel is also associated with the increase of throughput. The proposed change involves the addition of 1.6 m, to give a total trommel length of 6.8 m. There are a number of issues that need to be addressed with respect to the design of such an extension. These include the additional loads on the mounting and on the trommel itself. Thus, the strength of the trunnion liner, the trunnion bearing load capacity, bolted joint design, and trommel design need to be considered in detail.

It took over 25 years for the industry to accept an increase in grinding mill diameters from 36 ft (11 m) to 40 ft (12.2 m). This move allows over 30% increase in mill capacity (above the largest 11 m diameter mills), and also allows interesting reductions in capital cost. The work at Cadia confirms that these large mills can be designed, manufactured, and operated with the reliability that has become expected from large mills. In addition, power and performance expectations have been achieved. Others planning large concentrator projects can now apply these large mills with confidence that they will be successful.

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