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DESIGN OF THE 40 FOOT DIAMETER SAG MILL INSTALLED AT THE CADIA GOLD COPPER MINE

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ABSTRACT

The design of the 40-foot diameter SAG mill installed at the Cadia Gold Mine, New South Wales Australia, followed after two years of extensive laboratory and pilot plant testwork. This showed the Cadia ores to be hard and competent necessitating the use of both a variable speed mill drive and pebble crushing. The grinding power requirements were based on engineering in-house grinding software, pilot plant data and simulation using JK SimMet software. Surveys of the mill SAG during the first couple of months of operation were compared to those predicted. This paper reviews the findings and discusses some of the changes made to the SAG milling circuit.

INTRODUCTION

In 1998 the world's largest SAG mill and two of the world's largest ball mills were commissioned at Newcrest Mining's Cadia Hill property in New South Wales. The design of the comminution circuit and selection of mill sizes followed two years of study and evaluation of a wide range of alternatives, predominantly using simulation techniques. A detailed overview of the project from exploration to start-up has been presented elsewhere (Dunne et al 1999).

The Cadia comminution circuit comprises a SABC circuit with a single SAG mill and two ball mills in closed circuit with cyclones. Two pebble crushers treat the SAG mill discharge trommel screen oversize material. The crushed product is combined with the SAG mill feed. Project economics dictated maximum throughput through a single line comminution circuit. Hence the selection of some of the largest equipment available at the time.

Throughout the project Dr. S. Morrell (formerly at the Julius Kruttchnitt Mineral Research Centre (JKMRC) was the advisor to Newcrest on comminution modelling and simulation matters. Fluor Daniel was the engineer for the feasibility study and the Bechtel Minproc Joint Venture (BMJV) were contracted to carry out the EPCM. Prior to commencement of the engineering a flowsheet review was undertaken. This led to a number of equipment and layout changes in the comminution circuit
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The capital cost of the comminution circuit amounted to A$116 million. This includes the primary crusher, coarse ore stockpile, conveyors, grinding mills, recycle crushing and ancillaries (i.e. lime addition, ball addition). The SAG mill cost $12.2 million, whilst the SAG mill motor cost A$8.8 million for a total of A$21 million.

PHYSICAL PROPERTIES OF CADIA ORES

Laboratory test work data, shown in Table 1, indicated hard and competent ores (monzonite, monzodiorites and volcanics), although not necessarily of such competency as to create concern.

Table 1 Laboratory Comminution Data

Rock Type	Crushing Work Index		Rod Wi	Ball Wi	UCS		Point Load Index	
	kWh/t		kWh/t	kWh/t	MPa		MPa	
Type	Mean	Max	Mean		Mean	Std Dev	Mean	Std Dev
Monzonites								
Burgundy	24.1	28.6	16.0	17.4	31	-	4.9	1.9
Carbonate	23.2	33.8	16.1	19.2	139	31	6.1	1.3
Unaltered	22.8	25.2	17.3	19.1	161	45	2.8	2.5
Propylitic	25.6	32.3	19.1	21.4	131	58	7.0	1.1
Reddening	30.5	32.1	17.5	18.1	130	22	8.8	1.2
Phyllic	15.1	17.8	11.6	11.9	75	9.2	1.6	0.3
Volcanics	21.3	23.2	23.8	22.3				

Unconfined compressive strength (UCS) data from metallurgical testing were typical of a medium strength ore. More extensive testing carried out for geotechnical purposes, using single point load test, indicated average rock strength of 150-160 MPa, with some values in excess of 200 MPa and 300 MPa. This indicated a significant variation in ore competency and determined that the SAG mill and recycle crusher design would need to be flexible to cope with these fluctuations. This necessitated including use of both, a variable speed SAG mill drive, and the ability to handle variations in the pebble crusher feed rate.

Monzonite Bond ball mill work indices (Wi) averaged 17.1kWh/t, with a maximum variation of ±9%. The inferred average orebody Wi, based on laboratory grind times over a significant number of drill core samples, was 18.1 kWh/t (standard deviation 1.03 kWh/t). The pilot plant samples had Wi's of 17.4kWh/t and 17.3kWh/t, respectively. The Wi on various samples ranged from 15.0 to 25.4 kWh/t (including volcanic ores). The volcanics represent the harder and more competent component of the ore body.

The following JKMRC breakage parameters are those derived from ore treated during the pilot campaign (monzonite) and laboratory drop-weight test work on volcanics:

	A	b	ta
Monzonite	65	0.581	0.494
Volcanics	65	0.494	0.210

PILOT PLANT COMMINUTION TESTWORK

Two pilot plant trials on Cadia Hill monzonite ore were undertaken in 1994 and 1995. The first trial targeted a comparison of autogenous grinding (AG) and pebble crushing with semi-autogenous grinding (SAG). The second trial was to compare AG with SAG, both with pebble crushing using revised feed size distributions, ball size distribution and mill trommel size. These revised conditions increased the specific throughput, but resulted in similar overall circuit power consumption.

The pilot plant trials were conducted with a jaw crusher as a pebble crusher. Unfortunately, the jaw crusher was difficult to set to a fine crush size of 80% passing the pilot SAG mill trommel screen size. Therefore, the circulating load about the crusher was enhanced by an uncrushed 10mm to 15mm fraction.

The pilot plant trials were restricted to the monzonite ore. The ore sample tested was compared with monzonite and volcanic ore hardness, competency, and abrasiveness as determined from benchscale tests (eg Bond tests, media competency, pendulum tests, etc). The pilot plant sample was determined to be representative of the monzonite ore in most respects, with the exception of the Bond abrasion index. The abrasion index of the pilot plant sample was significantly lower than that for the majority of the monzonite.

METHODOLOGY FOR COMMINUTION SIMULATION AND DESIGN

JKSimMet Modeling

The model of the Cadia Hill SAG mill was based and derived from the pilot plant SAG (12% balls)/recycle crusher surveys. These were part of the second pilot campaign and were runs with two different load volumes of approximately 21% and 31%. The data from these tests were used to fit the breakage rate parameters and slurry flow parameters using the so-called variable rates model (Morrell and Morrison, 1996). These were then scaled to be consistent with the designed mill configuration at 12% ball, charge, 74% of critical speed and a new feed size (F_{80}) of 142mm.

A SAG mill feed size (F_{80}) was then chosen on the basis of the JKMRC ta- F_{80} correlation which indicated that a 200mm closed side setting in the primary crusher should give a SAG feed F_{80} of 153mm ± 15mm. The JKMRC comminution database was searched for a copper ore with such an F_{80}, which was used for the simulation study. Finally the model was used to adjust the rates to reflect the design requirement of an 8% ball charge. Full-scale mill power draw was predicted using Morrell's model (1996)

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The pebble crusher recycle load predicted by the model was determined by the combined action of the classification function and slurry transport models (Morrell and Stephenson, 1996). An Andersen/Whiten crusher model was used (Morrell et al, 1992) based on the performance of a 7' shorthead running with a closed side setting of 10mm. Power draw is inherently predicted by the model and is based on the degree of size reduction and the ore hardness as measured by JKMRC drop-weight testing.

BMJV Design Criteria

The determination of Cadia grinding circuit power requirements was conducted using Minproc's in-house grinding software, pilot plant data and review of simulations prepared by JKTech using JKSimMet software. The Minproc in-house software uses a combined reduced efficiency calculation, based on pilot plant SAG mill discharge size distributions, pilot plant SAG mill specific power, pilot plant ball mill specific power, pilot plant product size distributions and Bond-type calculations (as reported by Rowland (Rowland, 1982) and modified by Minproc).

The SAG mill was designed for monzonite ore, with allowance in the mine schedule for reduced throughput when treating the harder volcanics. The latter forms 7-8% of the orebody and have the potential to reduce throughput by up to 30% if treated by themselves, while maintaining the same grinding circuit product size.

SAG mill base power was estimated from pilot plant data at 7.8 kWh/t, the basis was a SABC circuit of 8% ball charge. Maximum SAG mill power was determined by deducting the installed ball mill pinion power of 7.95 kWh/t from the maximum overall circuit power of 16.7 kWh/t to give 8.75 kWh/t.

Overall power for the comminution circuit (SAG plus ball mills) base on a maximum ball mill Wi of 19.1kWh/t (ave. 18.1kWh/t plus one standard deviation of 1 kWh/t) indicated a maximum specific power requirement of 16.7 kWh/t.

Analysis of typical SAG mill installations in the copper industry indicates that typically less than 90% of installed motor power is used on average. Therefore, the installed SAG motor power was determined to be 9.72 kWh/t (8.75/90%). Checks were carried out to ensure that the SAG mill could utilise this power within a reasonable envelope of operating conditions.

CHOICE OF SAG MILL DIMENSIONS

The economics of the project dictated maximum tonnage through a single line comminution circuit incorporating the largest available equipment. At that time a 40-foot SAG mill had not been constructed. Fortunately detailed engineering, costing and an extensive risk assessment studies for a mill of this size were available. Iterative mine scheduling, incorporating net present value and internal rate of return calculations, demonstrated that treatment rates of the order of 17 Mtpa were needed for project viability.

With this in mind, and on the basis of 94% plant availability, an hourly ore treatment rate of 2065 tonnes was calculated. This, in conjunction with the specific power requirements (inclusive of contingencies) for SAG milling (9.72kWh/t) allows the SAG mill motor size to be determined (i.e. 20MW). Selection of SAG mill dimensions and operating parameters is a complex problem and suffice it to say here that it is advisable in the design to provide operating flexibility to increase power demand. Design parameters chosen for the Cadia SAG mill are shown the following table.

Table 2 : Cadia SAG Mill Design Parameters

SAG Mill Dimensions:			
Diameter – inside liners	(m) (ft)	12.04	40
Length – belly inside liners	(m) (ft)	6.096	22
Length – centre line	(m) (ft)	8.522	28
Trunnion diameter	(m) (ft)	2.235	18.6
Speed (fr. Critical)		0.74	
Grate aperture	(mm)(in)	25	1
Pebble port aperture	(mm)(in)	70	2.8
Open area fraction		0.1	
Ball charge volume	(%)	8	

GENERAL DESCRIPTION OF THE CADIA COMMINUTION CIRCUIT

The Cadia grinding circuit was designed to treat 17 Mtpa of monzonite ore and to operate at 2065 tph with 94 percent availability. Addition of volcanic ore would reduce throughput. The circuit consists of a single open circuit SAG mill with two parallel ball mills in closed circuit with classification cyclones. A recycle pebble crushing circuit treats critical size material discharged from the SAG mill. The design product particle size from the grinding circuit is 80% passing 150 microns.

Ore from the open cut mine is predominantly directly dump-trucked into a Fuller 60 x 110 gyratory crusher. Maximum design capacity of the primary crusher is 5800 tph with a product size of 80 % passing 200mm, this product is conveyed to a coarse ore stockpile.

The coarse ore stockpile has a design live capacity of 41,000t, which is equivalent to 20 hours of grinding circuit is approximately 160,000 tonnes and can be utilised by bulldozing the ore onto the reclaim feeders.

A full stockpile allows for a four-day shutdown of the primary crusher with minimal feed loss to the grinding circuit. The stockpile has a height of 39m above the reclaim feeders. It is recognised that a factor in determining the extent to which the stockpile reserve can be utilised is the potential for variation in the SAG mill feed size distribution through bulldozing, thereby causing control difficulties in the SAG mill.

A concrete tunnel under the stockpile houses three hydraulically driven belt feeders with variable speed drives. Each feeder draws ore from a mass flow hopper and has a capacity of 1250tph. The feeders can now deliver up to1800 tph after having been modified. Therefore, a minimum of two feeders operating at 82 percent capacity is required to feed the SAG mill. The feeders are spaced 20 meters apart and CCTV cameras are installed to allow operating staff to view the particle size of ore being drawn from each feeder. The belt feeders discharge onto the main SAG mill feed conveyor. This conveyor has a capacity of 3700tph which allows for a 20 percent increase over design of new feed and recycle crusher product. Two belt weightometers are installed on this belt. The first to measure the new feed rate and the second to measure the total SAG mill feed rate with recycle crusher product addition. Particle size analysis by means of a Split imaging system assists in maintaining an even size distribution of feed to the SAG mill.

The SAG mill is of Svedala design and 12.2m in diameter by 6.7m in length (40ft x22ft) operating in semi-autogenous mode. The SAG mill is supported by four hydrostatic pad bearings on each trunnion and is fitted with a 20 MW Siemens gearless drive motor with bi-directional rotational capability. Mill load is measured by means of two Kelk load measuring cells, mounted in the bearing assembly on the mill discharge, and Rosemont pressure transmitters on oil flow feeding four feed and discharge end bearing pads. The discharge grates originally were 70mm slots allowing pebble discharge for recycle crushing. A 4.5m diameter by 5.2m long trommel screens the discharge product. It is fitted with 320 screen panels and the original rubber panels had slot dimensions of 13mm by 32mm. The effective screen area was determined to be 14.2m2 and the total open area was 24 per cent. SAG mill discharge onto the trommel of a particle size less than 12mm falls directly into the cyclone feed pump hopper. Oversize pebbles from the trommel are conveyed to a split surge bin of 735 tonne capacity, adjacent to the recycle pebble crushers. Ahead of the surge bin there are two Eriez belt magnets (series SE 780-SC1), mainly for steel ball removal, followed by a Ramsey Oretronics tramp metal detector. In the event that steel balls, or other metal, are not removed by the magnets and detected by the metal

detector a crusher by-pass system, back to the feed conveyor, is activated. Variable speed belt feeders, below the pebble bins, transfer the pebbles to two Nordberg MP1000 cone crushers and are located such that their product falls directly onto the SAG mill feed belt. The crushers are designed to each crush 525tph with an expected total recycle pebble rate of 725tph. The design product size from the crusher is around 80 percent passing 12mm.

ACTUAL PLANT VERSUS DESIGN AND PILOT PLANT DATA

During the start up period of the Cadia Hill concentrator a progressive and detailed research program was undertaken over 4 weeks in order to assist in developing a link between pilot and full scale plant comminution models. The grinding circuit was operated and surveyed under steady state conditions in autogenous and semi autogenous mode.
The following Table provides a summary of pilot plant surveys with the full-scale plant equivalent.

Table 3 Operating Data Comparison for Pilot and Actual Plant

Parameter	Pilot Plant	Design	Plant Survey (23/07/98)
Feed Rate (tph)	-	2065	2092
Feed F80 (mm)	102	150	98
Ball Load (%)	12	8	12
Total Load (%)	31	25	26
Speed (% Critical)	76	74	78
Grate Opening (mm)	10	25	70 & 90
Pebble Port Opening (mm)	70	60	-
Pebble Rate(% New Feed)	68	35	23
Product T80 (mm)	5.1	3.8-7.6	1.34
Product <150um (%)	33	25.	42
SAG Specific Power (kWh/t)	7.2	7.8	8.6

The main factor that has benefited the plant operation compared to design is the SAG mill feed size distribution, which is 40% finer than design and slightly finer than was used during the pilot plant campaign. In the design there was a high reliance placed on achieving high pebble production rates and crushing efficiency. In practice, the predicted rates have not been achieved. The SAG mill discharge particle transfer size T80 and T50's are finer than predicted (56% finer). The specific power consumption is higher than design because of the higher steel ball load and average throughput rates are slightly lower than design. Throughput rates have varied between about 1600tph and 2400tph. The lower throughput rates correspond to treatment of more competent volcanic ores, which as mentioned previously impact on throughput rates.

In the case of the pebble crusher circuit the actual pebble production was found to be lower than design. The higher than predicted pebble recycle loads, based on the JKSIMMET model, may have resulted from unrealistically high solids flow predictions due to the difference in modeled flow characteristics between coarse solids (pebbles) and slurry. To overcome this in the short term the JKMRC have collected data from a number of SAG mills with recycle crushers and a relationship has been developed which relates the maximum solids flow to the grate/pebble port open area. This maximum is then applied during simulations to limit the predicted recycle rate to achievable levels. The model deficiency is being tackled in one of the comminution research programmes at the JKMRC (AMIRA P9 project).

COMPARISON OF PILOT PLANT AND PLANT PERFORMANCE

The comparison between pilot and full-scale plant results, shown in Figure 1, demonstrated improved efficiency of breakage in the plant, evident in the improved AG and ABC performance as a result of the much higher impact energies in the 12.2m diameter mill. This is possibly due to a more favourable range of energies in the full-scale mill", however it could also be due to differences in pebble crusher operation, feed size distribution and also how net power is estimated.

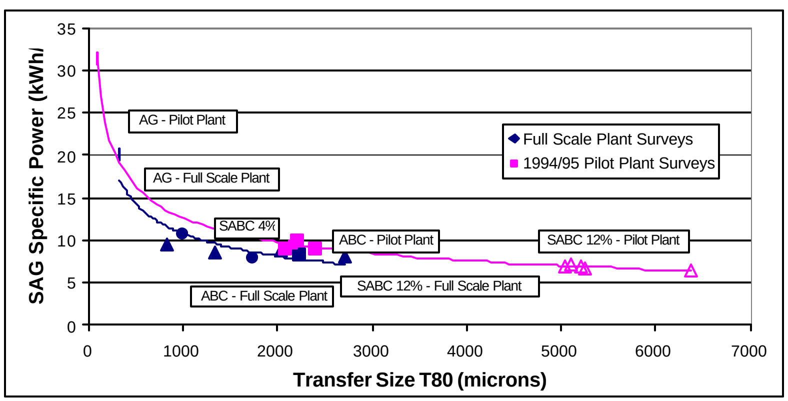

Figure 1 Comparison of Pilot Plant vs Full Scale Plant Performance

Comparing pilot plant (6 foot diameter mill) performance and full-scale (40-foot diameter mill) performance revealed;

- AG mill performance with no pebble crushing improved between pilot plant and full-scale plant. The power requirement was 10kWh/t lower and the transfer size coarser indicating improved breakage in the larger diameter mill.
- Comparing ABC circuits between pilot plant and full-scale plant again demonstrated improved performance of the 40-foot diameter mill. The transfer size was similar in this case but specific power lower by about 1kWh/t.
- For SAG milling a finer product was generated at a higher specific power consumption in the full-scale mill.

Pilot plant testwork clearly demonstrated the importance of pebble extraction and crushing of this component in determining overall circuit efficiency.

Evaluation of SAG Mill Power Draw

The design of the 40 foot diameter SAG mill motor was such that up to a mill operating speed of 74% critical, power would be delivered at constant torque. Above 74% and up to the maximum of 85% of critical speed, constant power would be delivered. The following Figure 2 demonstrates the effect as well as the vendor design estimates.

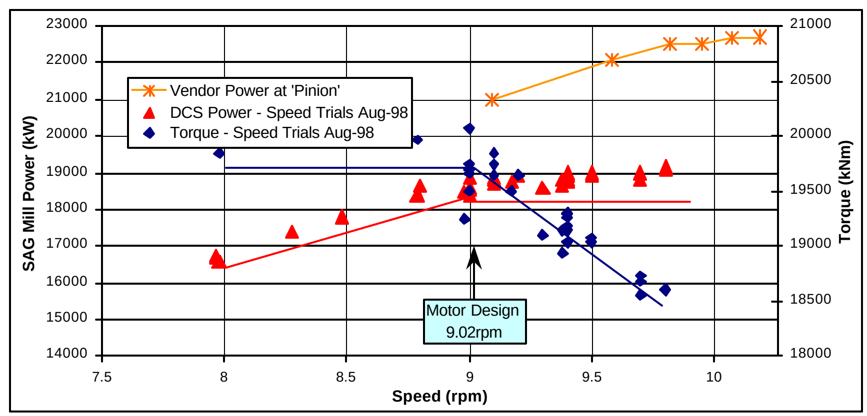

Figure 2 Power and Torque vs Mill speed for 13% Ball Charge

The warranted at-shell power draw according to the vendor contract is given in Table 4

Table 4 Vendor's Guaranteed Power Draw at Different Operating Parameters

Percent Mill Volume	Percent Ball Charge	% Critical Speed	KW at Mill Shell	Guarantee Power (5% deduction) Kw
20	13	78	20.3	19.3
24	13	78	21.1	20.1
30	13	78	22.1	21.0
20	5	78	14.4	13.7
24	5	78	15.6	14.8
30	5	78	17.0	16.6

Measured SAG Mill power draw, shown in Table 5, was lower than expected. The design guarantee point for the 40 foot diameter SAG mill is compared to actual plant performance during plant surveys and vendor trials conducted during the plant commissioning phase.

Table 5 Actual SAG Mill Operating Power

Mill Parameter	Unit	Plant Survey 1	Plant Survey 2	Vendor Trial		
Date		23-Jul-98	23-Mar-99	28-Aug-98		
Ball Charge Volume	%	12.0	14.0	13.0		
Total Charge Volume	%	26.1	33.0	35.0		
Speed (% of Critical)	%	78.0	78.0	62	70	78
Power Draw at DCS	**MW**	**18.00**	**19.32**	**15.2**	**17.8**	**19.2**

The power at DCS is approximately 4% higher than the power at shell. Thus the nominal vendor power was around 2MW higher than the measured power. Further data gathered during commissioning indicated that the mill was drawing between 1 MW and 2 MW less than the vendor "design data". The reason for this differential is partly due to the slightly smaller actual internal dimensions of the mill, used by the vendor in their warranty calculations. The remainder of the power differential appears to be due to a deficiency in the vendor's power model.

The Morrell power calculation methodology and Minproc's in-house program (based on the Allis Chalmers mill power calculation) predicted the observed power to within 2-4%. This is well within the errors expected in measuring ball volume, total volume and power draw.

DISCUSSION ON PERFORMANCE OF EQUIPMENT IN SAG CIRCUIT

SAG Mill and Motor

Vibration and deflection in the SAG mill motor was a problem at start-up and for some months thereafter. The onset of excessive vibration depended on the mill speed and load, motor and ambient temperature and motor eccentricity. The installation of chocks between the stator and rotor provided some relief to the problem. However, unpredictable power trips, whilst inching during relining, and the requirement to operated at low speed, until the motor temperature had stabilised, mainly after relining or lengthy shut downs impacted on production. Thus, a more permanent solution to the problem was required. One was found (Meimaris and Cox, 2001) and implementation resulted in the installation of a "strongback" (stiffener) to the motor stator and this has successfully resolved the problem.

Throughput and SAG Mill Operation

The SAG mill operated at a relatively high mill filling during and for some months after commissioning. The high load was principally driven by the damage to liner and balls resulting from operating at mill loads below 30% filling with the high ball charge (> 8% balls). Changes to the mill lifter design and profile have alleviated this problem (Hart el al, 2001).

The outcome of operating the mill at high load is a fine SAG mill product size. The proportion of fines (<150 micron) produced is proportional to the rock charge for a given ball load (Lane el al, 1999). Thus for a hard/ competent ore, as the mill load increases, the power expended per tonne treated increases, often leading to a reduction in throughput if the ore is sufficiently competent. A parallel reduction in the "efficiency" of the circuit results with the total circuit power increasing by 10% to 15%. These effects are compounded by the lower than design circulating loads through the pebble crusher.

SAG Mill Trommel Screen

Benchmarking during the design stage against other large SAG mills with trommels suggested that some form of damming / baffling of the Cadia trommel was required to limit flooding of the trommel and promote drainage of slurry in the first 35% of screen length. The review also raised the possibility that the trommel may be undersized and providing little or no scope for improved mill performance. An option for increasing throughput by installing a dewatering screen at a pebble transfer point was proposed. This facility was not designed and was only considered on a conceptual basis.

At start-up it became evident that the trommel was undersized leading to both water and fines carry over onto the recycle pebble conveyor. The problem is exacerbated as recycle loads increase and more so above 600 tph, resulting in substantial increased water and fines reporting to the pebble surge bin. This causes reduced pebble crushing efficiency for the MP1000 units. This affect is more prominent in the first crusher due to a disproportionate build up of water and fines in the surge bin closest to the discharge end of the recycle pebble conveyor.

The first set (and replacements for some six months) of trommel panels wore at a significant rate. Comparison of sixteen different types of panels has, thus far, shown that rubber is better than urethane and that steel reinforcing is essential. Panel life in excessive wear areas has increased from two to sixteen weeks with these changes.

SAG Mill Liners and Grates

The Cadia mill SAG mill lining system was developed based on discussions held between Newcrest's project team, Bechtel Minproc Joint Venture, Svedela, and liner system vendors (ME International and Norcast). These discussions centred mainly on three issues for the SAG mill.

The first issue related to the liner profile and the merits of the traditional plate and rail versus the newer “top hat” design. The top hat lifter design was selected after consideration of the physical metallurgy of the liner system and recommendations from liner suppliers.

The discharge grate design chosen incorporated design features developed by the vendors at other large SAG mill operations. These features included the use of "ninja" hat at the top of the grate section to protect the grates

from ball impact. A full set of discharge grates that incorporated 70 mm slots and a half set of 25 mm slots was ordered for mill commissioning. The 70 mm slotted grates were installed to maximise the feed to the pebble crushers.

The number of lifter rows to be incorporated in the mill was a matter of much discussion during the design phase. Prior to final agreement amongst the parties, the mill vendor informed BMJV and Newcrest that the mill shell had been drilled for 78 rows based on past experience. The initial liner set consisted of 78 rows of 275 to 325 BHN lifters in a Hi/Lo profile with a face angle of 12 degrees. The shell liners consisted of 78rows of high-low configuration using the “top hat” design. All liners were cast from pearlite chrome-moly steel with 0.6 percent carbon content and a mean hardness of 325BHN. The plant was commissioned on 125 mm balls with a hardness of 57 Hrc. The lifters were found to pack with balls as well as throw balls against the mill shell. The latter contributed to ball breakage and liner peening at high speeds and low mill loads (i.e. above 74% critical speed and below 30% mill volume.) To overcome ball breakage the ball hardness was reduced from to 54 Hrc. To combat ball throw, liner peening and damage a new liner design consisting of 52 lifters, with a face angle of 25 degrees, in 52 pieces (maximum 2.7 t each) with alternate top hat and liner bolt holes was installed during December 1998. Immediately ball packing stopped and ball breakage decreased dramatically. Furthermore, mill speed could be increased allowing better mill performance especially as shell liners wore and ball slippage increased.

Pebble Crushing

The two MP1000 pebble crushers have had problems with tramp metal. Problems with magnet operation, metal detector operation and the low tolerance of the MP1000 to tramp metal (when compared with a Symons 7ft SXHD) have resulted in several cracked mantles (possibly due to poor castings). Intermittent problems with the metal detector and flop-gate (total intermittent failure) have contributed to the problem.

The pebble crusher bypass system initially operated up to 200 times per day reducing plant throughput. Improvements to the magnets and metal detectors reduced this significantly. However the problem was only satisfactorily resolved by the installation of a third and stronger magnet. .

BMJV recommended three Nordberg HP700 crushers instead of two MP 1000 units after conducting a case study that considered capital cost and operability and reliability issues. Three units were recommended due to the increased flexibility of three crushers when compared with two larger units. The use of two units was thought to have a larger impact on SAG circuit stability. Issues associated with MP1000 reliability were reviewed and the vendor convinced both the BMJV and Newcrest that most of the operating and maintenance issues had been addressed (probably true for a secondary crusher duty). Newcrest on the basis of cost savings (of the order of $1 million), simpler distribution of ore into surge bins ahead of the units and overall prevailing project philosophy selected the two MP 1000 units.

CONCLUSION

Simulation based on models which describe as far as possible the physical processes which take place in comminution and classification machines can be used to great effect when designing a new plant. However it should be born in mind that models and simulations are not absolute in themselves. They provide insight on both process variation and the magnitude of change as input parameters vary. None of the models, simulators or engineers in the field provides the same answers. The dilemma for the project client is how to select a solution to the problem knowing that more advice will only further complicate the issue.

The Cadia experience has demonstrated that hard and competent ores are amenable to SAG milling. The inclusion of a properly designed recycle pebble crushing is an integral part of the circuit for these types of ore. The crusher's duty is onerous as high availability and high reduction ratios are required. To attain high throughputs in the SAG mill it was found necessary to operate with a high ball charge and low rock charge at relatively high critical speed. These conditions favour impact breakage rather than attrition. The outcome is that specific power requirement are reduced. In essence this means more throughput for the same power draw, however the transfer size increases (coarser grind). Comparison of pilot and large-scale operation has show that the energy efficiency in the large mill was not as good as the smaller pilot mill. This still appears the greatest variable to be overcome in the quest for higher throughput through the larger mill. Furthermore operating at high rock loads does not necessarily provide maximum throughput nor optimise power consumption.

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