Expert mill control at AngloGold Ashanti

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Synopsis

AngloGold Ashanti Metallurgy has recently been involved in the successful installation of intelligent, expert control systems on the milling circuits. The benefits of expert systems in these highly interactive circuits are obvious. Existing comminution tools, which have been developed and can now be incorporated into online control, include improved modelling techniques and understanding, robust and competent simulation methods, sampling techniques, and optimization methods. The minerals processing industry has seen the benefits of predominantly research-based centres turning their focus to commercial applications of comminution circuit modelling packages, which in turn can be utilized within expert control systems.

Expert mill control has been successfully installed at AngloGold Ashanti South Africa's Mponeng and Kopanang Gold Plants. Expert control has also been installed at AngloGold Ashanti's West African Sadiola Mine operation. The implementation of the systems has produced a number of positive outcomes. Plant surveys usually result in the identification of sub-optimal areas, and the control philosophy is then configured to ensure that these areas (along with the entire circuit) are optimized and maintained. Outdated PID loops have generally resulted in oscillatory control with large amplitude deviations from set-point. Significant improvements in SAR Metallurgy operations have been realized, firstly through achieving stability in the load and cyclone control, and secondly through online identification and implementation of optimized set-point conditions for mill mass, discharge density, etc. Soft sensors are configured to accurately estimate parameters that were historically not measurable, viz. breakage rate, mill load condition, online kWh/t-75 microns, mill discharge density and cyclone overflow grading.

The Mponeng Plant system achieved circuit stability and improved overall grind. The Plant was able to pay back the control installation after 3 months, based on the additional recovery obtained from the finer grind. The system at Kopanang Plant has also resulted in enhanced plant recovery as a result of a finer grind and a lower residue gold content. The payback for this system was calculated at approximately 6 months.

AngloGold Ashanti Metallurgy is currently expanding the installation of expert control to its other operations. It is also evaluating the performance of various suppliers of advanced control systems.

Introduction

The typical South African ROM (run of mine) SAG (semi-autogenous) milling circuit is described with the emphasis on the process control systems employed. The history of the circuit (process) controller is then discussed briefly to illustrate the differences between historical and new techniques. The evolutions of the control philosophy, as well as the financial benefits, are described. Global research has produced useful modelling in the field of comminution. The interpretation of the available learning and its implementation into SAR Metallurgy plants has improved operating efficiencies with the accompanied economic benefits.

The control philosophies currently adopted within AngloGold Ashanti's Mponeng Plant, Kopanang Plant and, in the near future, Noligwa milling circuits represent the latest advanced control technologies. Development has also been carried out in-house to suit the specific needs of each site. The paper concludes with results obtained from the installation of expert control software at the plants mentioned above. Future philosophies and the broader holistic approach to mill control are discussed.

The ROM SAG mill circuit—a brief description

The typical ROM SAG mill circuit is depicted in Figure 1. The circuit is usually closed with either a screen or, more commonly, a cyclone for product size classification. The focus of control can be divided into two parts, viz. the mill and the cyclone. The importance of cyclone performance should not be underestimated as it is directly related to the product particle size distribution and consequently the performance of the milling circuit as a whole. The properties of the cyclone product are directly related to the properties of the cyclone feed material. The performance of the cyclone is therefore bounded within an envelope dictated by the

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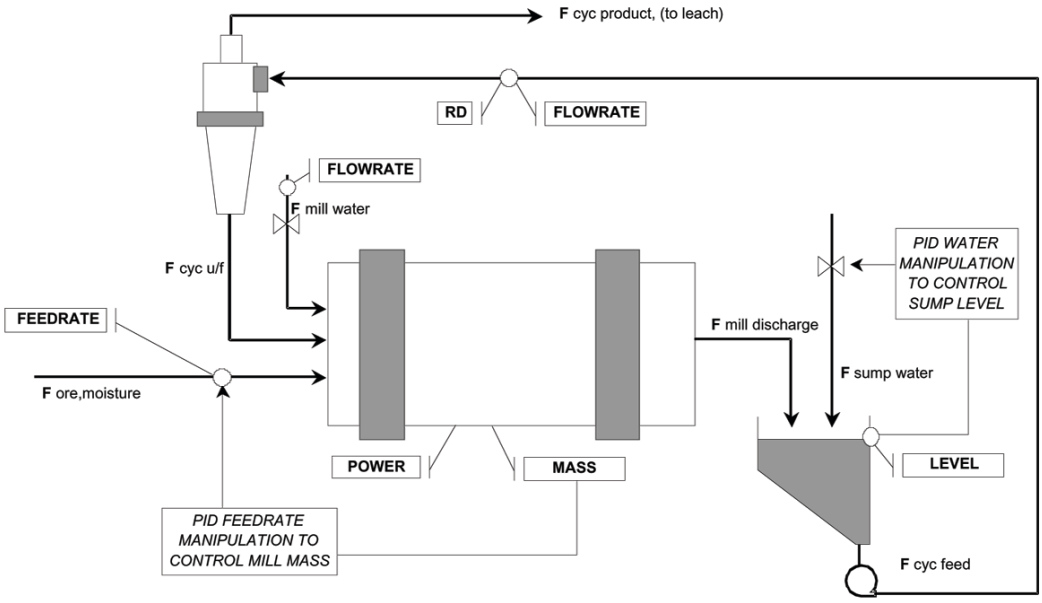

Figure 1—Typical SAG milling circuit, basic instrumentation shown

cyclone-feed qualities. In order to operate the cyclone at the optimum end of this envelope the output of the mill discharge sump should be stabilized at the optimum conditions. The cyclone settings can then be tuned to maximize efficiencies. Once the cyclone optimization has been exhausted, it is then possible to shift the entire 'efficiency envelope' by optimizing the operation of the mill itself.

In both cases, optimization takes on both discrete and continuous forms. Unit parameters that best suit the operating conditions can be identified by means of expert control.

The history of mill control

Advanced process control has progressed extensively in the past few decades, and will no doubt continue to improve in the coming years. An improving understanding of the milling process, together with the development of techniques to utilize this knowledge, continue to fill the gaps still present in the research and minerals processing sectors. On line application of discrete element modelling is imminent.

Previously, the temperature of the mill discharge slurry would be felt by hand in order to assess the efficiency of the power/tonnage ratio. It is still common to listen to the side of a tumbling mill to develop a mental picture of the load geometry. These past practices are being utilized within modern control instrumentation. For example, Pax[1] utilizes acoustic techniques to determine the load shape online.

The PLC (programmable logic controller) was the most significant of the pioneering computational-based online controls. The common PLC serves as the platform for the use of PID (proportional-integral-derivative) controllers. A PID controller is essentially used to measure the deviation between a process value and its desired set-point, and then stimulates a positive or negative change in an appropriate variable to nullify the deviation. A PID controller is perfectly suited to a system involving only a handful of, preferably, non-interactive variables. For example, in order to control the level of water in a tank, a PID loop could reliably open or close the inlet valve based on a level measurement. As soon as more variables are added to the system, however, the controllers then compete for control and the situation becomes complex due to an increase in the interactivity of the system. In addition to this, the PID controller is typically tuned to work for a known set of operating conditions. When these system conditions change, the tuning parameters become less suitable. An example of this is the power draw of a mill, which is related to the mill load. If a particular mill mass setting creates poor mill performance, then a new mass set-point will be needed in order to maximize power draw. A PID controller is able to control only at the given set-point, and is unable to recognize such a development in the circuit. It is also incapable of self-tuning. Such developments occur constantly in any grinding circuit, implying that PID (on its own) cannot optimally control a grinding circuit. Expert control systems have been developed in recent years in response to this need.

The expert control system has evolved to consider the condition of the entire milling circuit, whereas the PID controller would only maintain the set-point of the unit to which it has been assigned. The expert system therefore assesses the degree of optimized behaviour, and allows for interaction to correct for deviances, and more importantly, optimal values for set-points. This is achieved through the ability to write 'if/then' rules, set fuzzy controllers and make use of highly sophisticated data-integrity filters such as the Kalman filter used within AngloGold Ashanti control systems.

Examples of intelligent control applications are numerous. Mintek has adapted its Plantstar[2] control application to include a more sophisticated version for mill control. Los Pelambres Mine[3] uses Knowledgescape's adaptive control software, and has realized benefits that include process stability. Metso Minerals' OCS[4] (optimizing control system) is the control system of choice at Mponeng and Kopanang plants, and will be compared against the Mintek system at Noligwa Gold Plant in 2004.

Past performances—what it cost

The chemical dissolution of solid gold is directly dependent on the degree to which it is liberated from the host matrix. A typical grind-recovery relationship is shown below in Figure 2. (Note: this particular curve does not contain real experimental data, but gives a realistic view of the concept.)

The transient nature of the gradient immediately suggests that there will be an economic turning-point where the additional effort required to mill finer is no longer justified. The greatest benefit is derived from improving recoveries by improving the grind from 5%<150 μm to below 2%.

Table I illustrates the rand value of a 2% difference in the total recovery of a typical gold plant with a head grade of 5g/t (@ R85 000/kg Au). The revenue generated/lost by this difference is significant, justifying the need for plant optimization.

Considering a mine with a head grade of 10 g/t (see Table II), the financial implications are doubled.

Evolution of advanced mill control

The history of process control from the PID loop to expert systems incorporating rule-based systems and fuzzy systems, has been described, with reference to their application within AngloGold Ashanti SAR Metallurgy. The modern advanced control system is able to use as many variables as are required for model input. Certain immeasurable, yet critical, process values can then be calculated from the available data—e.g. the mill discharge density. Until recently, not much confidence could be placed in process models due to the error margins and noise associated with measured plant data. Specific values can now be measured and predicted via a model, which then provides the freedom to correct and filter dubious data. Some of the typical models used online are described below.

Circuit models—understanding each circuit

The traditional saying 'you cannot control what you cannot measure' is no longer valid as you can now also 'control what you can model'. The models below have been selected for 3 reasons. Firstly, they have been extracted from respected research currently done in the field of comminution. They have been validated on industrial applications, and are the foundation of the more competent control systems today. Secondly, a great deal of input data is needed for the Morrell power model[5]. The gross power of a mill can be reliably measured, enabling at least some of the 'immeasurable values' to be implied. Finally, the fact that models exist for mill power, breakage, hold-up, etc. means that it is possible to perform more reliable population balances across the mill. The integration of the models is essential to the success of the advanced control systems.

Mill power

$$Gross\ power = no-load\ power + (k \times charge\ motion\ power)$$

$$No-load\ power = 1.68\left(D^{2.5}n(0.667Ld + L)\right)^{0.82}$$

where D = mill diameter
L = cylindrical length
L_d = conical length
n = fraction of critical speed

$$Charge\ motion\ power = \left((\pi g L N_m r_m)/3(r_m - zr_i)\right)\left(2r_m^3 - 3zr_m^2 r_i + r_i^3(3z-2)\right)\left(\rho_c(\sin\theta_s - \sin\theta_T) + \rho p\,(\sin\theta_T - \sin\theta_{TO})\right) + L\rho c\left(N_m r_m \pi/(r_m - zr_i)\right)^3\left((r_m - zr_i)^4 - r_i^4(z-1)^4\right)$$

where ρ_p = slurry density
ρ_c = grinding charge density
θ_{TO} = slurry toe angle for overflow discharge mills (= 3.395 rad)
= θ_T for grate discharge mills
θ_s, θ_T = geometrical parameter

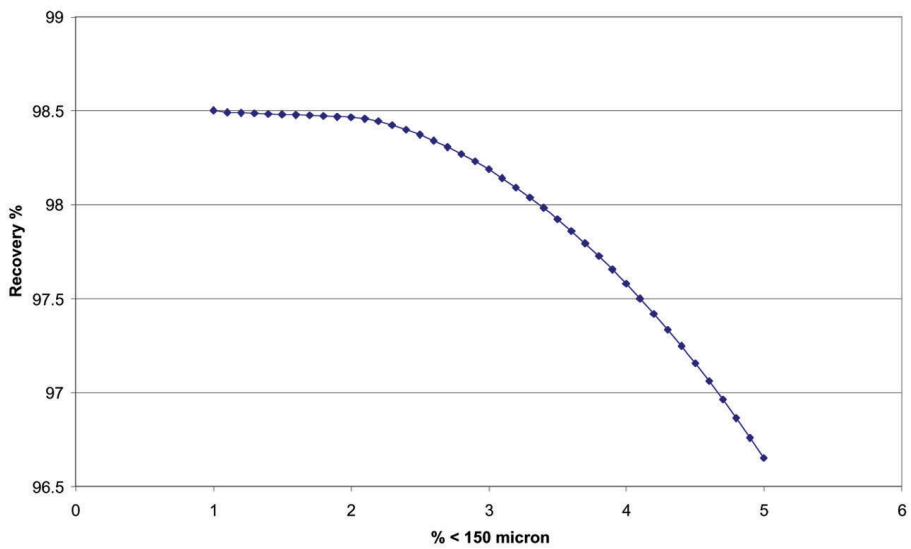

Figure 2—Typical grind-recovery curve (not real data)

Table I

Cost of poor recovery at 5 g/t

Illustration of revenue loss through low recovery		Typical plant	
		Scenario 1	Scenario 2
tons/month	t/m	200 000	200 000
head grade	g/t	5	5
kg Au into plant	kg/m	1 000	1 000
recovery	%	96%	98%
kg Au to residue	kg/m	40	20
kg Au recovered	kg/m	960	980
difference in Au recovered	kg/m	20	
revenue loss per month	R/m	R1 700 00	
revenue loss per year	R/y	R20 400 000	

Table II

Cost of poor recovery at 10 g/t

Illustration of revenue loss through low recovery		Typical plant	
		Scenario 1	Scenario 2
tons/month	t/m	200 000	200 000
head grade	g/t	10	10
kg Au into plant	kg/m	2 000	2 000
recovery	%	96%	98%
kg Au to residue	kg/m	80	40
kg Au recovered	kg/m	1 920	1 960
difference in Au recovered	kg/m	40	
revenue loss per month	R/m	R3 400 00	
revenue loss per year	R/y	R40 800 000	

Breakage rate[6]

The breakage model, used in tandem with an appropriate population balance, allows the estimation of load characteristics. Together with the hold-up model, it is possible to predict discharge slurry density.

$$\textit{Mill throughput } \alpha\, r.s.\,(1-a)$$

where r = breakage rate
s = rock load mass
a = appearance function

Hold-up[6]

$$H_p = k(GD)^a(OA)^b(CV)^c(CS)^d Q^e$$

where H_p = net fractional slurry hold-up
OA = fractional open area
CV = fractional charge volume
CS = fractional critical speed
Q = flowrate
GD = grate parameter based on hole design
k = coefficient of resistance
a,b,c,d,e = model parameters

Cyclone[7]

The Plitt model predicts cyclone performance and control. This model can be employed to improve plant efficiency.

$$d50_c = F_1 39.7 D_c^{0.46} D_i^{0.6} D_o^{1.21} n^{0.5} \exp(0.063C_v)/$$
$$D_u^{0.71} h^{0.38} Q_f^{0.45} \left[(\rho_s - 1)/1.6\right]^k P = F_3^{1.88} Q_f^{1.8}$$
$$\exp(0.0055C_v)/D_c^{0.37} D_i^{0.94} h^{0.28} \left(D_u^2 + D_o^2\right)^{0.87}$$

$d50_c$ = 50% passing size
P = pressure drop
D_c = cylinder diameter
D_u = spigot diameter
D_o = vortex finder diameter
D_i = inlet diameter
n = medium viscosity
C_v = feed solids volume%
h = distance between vortex finder and apex
k = hydrodynamic exponent
Q_f = flowrate

The AngloGold Ashanti approach—control philosophy and circuit stability

Metso Minerals' OCS package has been successfully installed at Mponeng and Kopanang gold plants. The OCS will also be installed at the new Noligwa milling circuits. The OCS includes many of the advances in process control that have been discussed thus far. Figure 3 details an overview of the control loops in OCS.

The mill feedrate is controlled by a fuzzy response to mill mass set-point. The fuzzy sets are tuned to minimize over/under-shoot mass control. The rates of change in mill mass and power are monitored to determine load status. The load status will prompt responses by the expert system to decide on an optimized mill mass set-point. The kWh/t is also calculated, and is used in the control strategy to optimize the power to tonnage ratio. The entire circuit is mass-balanced to produce a model output for the mill discharge density. The value of this figure is that it allows for the optimization of the fine-grinding conditions in the mill load. The discharge density is then controlled via manipulation of the mill inlet water.

The discharge sump level and cyclone feedrate are controlled by the PLC. The OCS controls the cyclone by deciding on an inlet pressure set-point. The density to the cyclone is more or less maintained by the fact that the mill discharge density and the sump level are both controlled. The pressure controller therefore has a more direct effect on inlet pressure, and an indirect effect on cyclone density.

Figure 4 describes the method used by the OCS to calculate the immeasurable variables, i.e. the 'soft sensors'. For example, the mill discharge density cannot be measured. If the density in the mill load slurry is too high, the grinding efficiency will be poor. If the density is too low, then excessive media wear will occur. The mill discharge density is valuable soft sensor. A certain number of parameters are measured, as well as predicted by the process models. Specific confidence limits are placed on each parameter used. The measured and predicted figures are compared, and the model parameters are corrected according to their weighted confidence, until the model matches the measurement. The model parameters are therefore now assumed to be relatively accurate, and are then used to derive the soft sensors.

Two advances have been made to improve control within AngloGold Ashanti's OCS applications. The mill discharge density soft sensor has been optimized at Mponeng Plant via the use of temperature measurements[8] and energy balancing. A more accurate technique has been used to model the discharge density. Via model redundancy, it was possible to

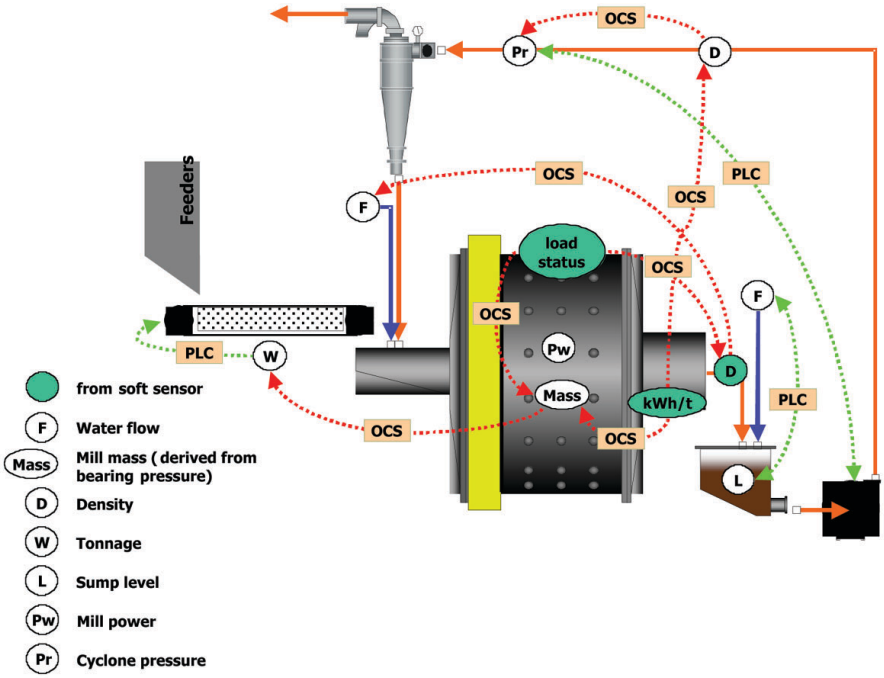

Figure 3—The Metso OCS approach at Mponeng and Kopanang plants

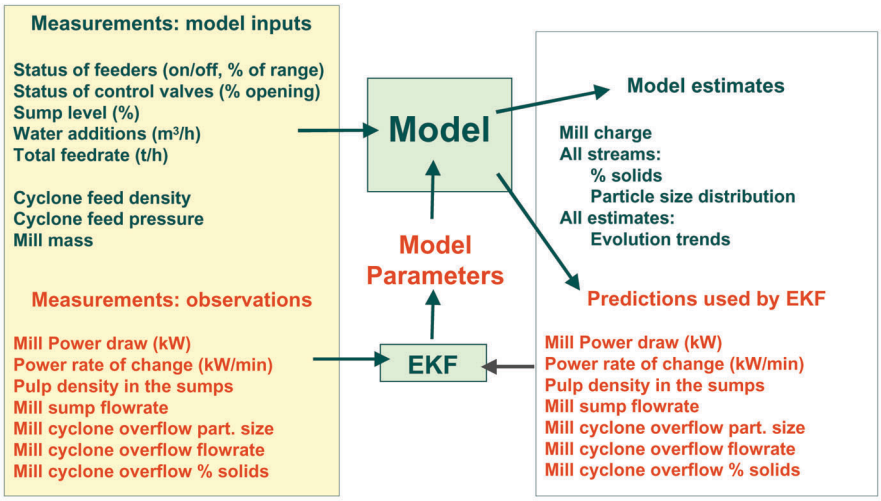

Figure 4—The Kalman filter structure for soft sensors

identify erroneous process data used for conventional control. Correction of the input data thus produces a more accurate OCS prediction of the soft sensor.

The OCS at Mponeng Plant has been configured for the PSI (particle size indicator), which is installed on the cyclone overflow stream from mill 1. The measurement of the cyclone overflow size provides an additional degree of freedom for the Kalman estimation of the ore breakage characteristics. This makes the system more competent to optimize the mill. Kopanang Plant does not have a PSI, and consequently the cyclone control loop has been adjusted accordingly. The cyclone overflow particle size has been modelled, and the controller has been configured to give preference to optimization of this value. The accuracy of the model is maintained by a daily input of the gradings measured by the shift staff. The controller then seeks to set a target for %<75microns that exceeds the current value.

Figure 5 shows poor operation and optimized mass control in an attempt to show the importance of stability. In order to achieve excellent control, the mill mass is expected to vary by approximately 5 tons around the set-point. This ensures that the size distribution in the mill load is well balanced, i.e. coarse material for breakage and finer material for abrasion. The poor mass control falls outside of the optimum regime for approximately 50% of the time. When the mill is under loaded, there are too many ball-liner impacts, which are detrimental to the liner life. The breakage events also decrease, and the balance between breakage and grinding is lost. When the mill overloads, the material in the mill then centrifuges and effectively clings to the walls of the mill. This results in a drop in mill power and throughput. During normal operation, when mills overload, the operator often responds slowly, sometimes drastically cutting mill feed. Consequently, the mill mass drops rapidly into the

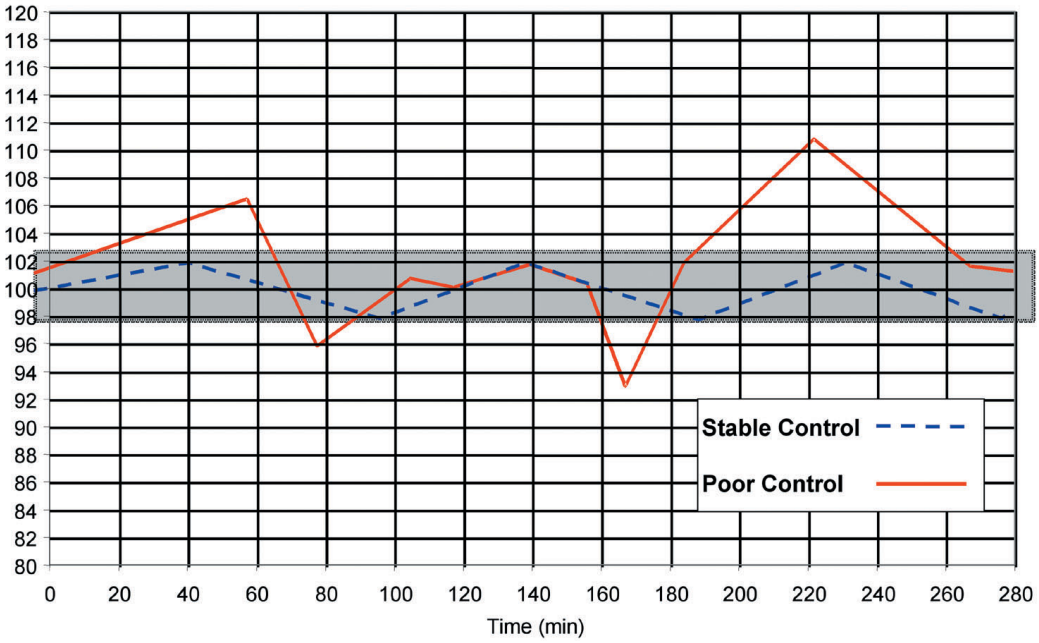

Figure 5—Stable versus poor mill mass control

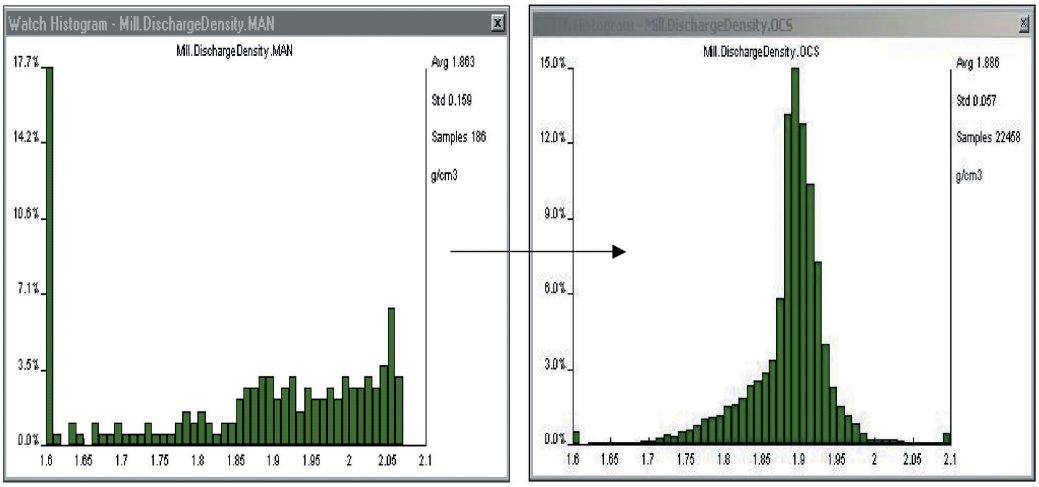

Figure 6—Mill discharge density controlled manually (left) and with OCS (right)

optimum envelope (see above, at 60 minutes). As can be seen, the mill mass has been corrected, but the upper end of the size distribution of ore in the mill is reduced, thereby having a negative effect on the grinding during this time. This will continue for approximately two residence times after the feed has been restored, which means that the mill has actually been operating inefficiently when the mass seems to be within acceptable limits. Poor control has therefore resulted in the mill having operated inefficiently for more than 50% of the time depicted. This highlights the need for stability.

Results achieved—AngloGold Ashanti South Africa

As previously mentioned, the OCS is installed at Mponeng and Kopanang gold plants. The results of each plant are shown below. The Noligwa Plant control system had not yet been installed at the time this paper was written.

Mponeng Gold Plant[9]

OCS was installed at Mponeng Plant during 2000/2001. The control philosophy was aimed at optimization of the grind. This was achieved, particularly through the improved control of the mill discharge density. Figure 6 shows two histograms for the mill discharge density. The chart on the left shows the spread of the values before the installation of the OCS. The arithmetic means are similar in value, but it is obvious that the introduction of the OCS has tightened the control considerably.

Figures 7 and 8 (following page) show the cyclone overflow grind size and the plant recovery respectively. The percentage of >150 micron material was decreased appreciably, which resulted in the improvement in total plant recovery. The plant is currently achieving gradings of >150 micron material of 0.6% or less, and recoveries in excess of 98% consistently.

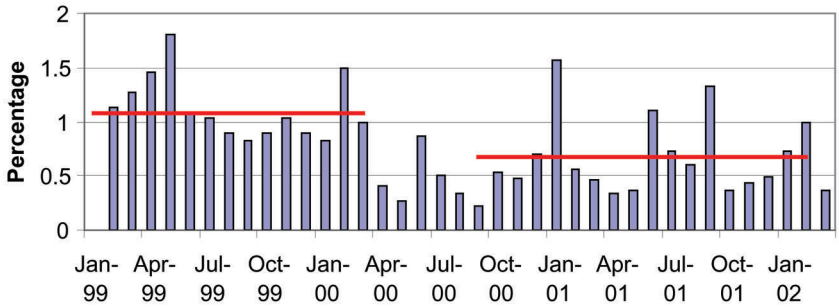

Figure 7—Cyclone O/F % > 150 micron, Mponeng Gold Plant

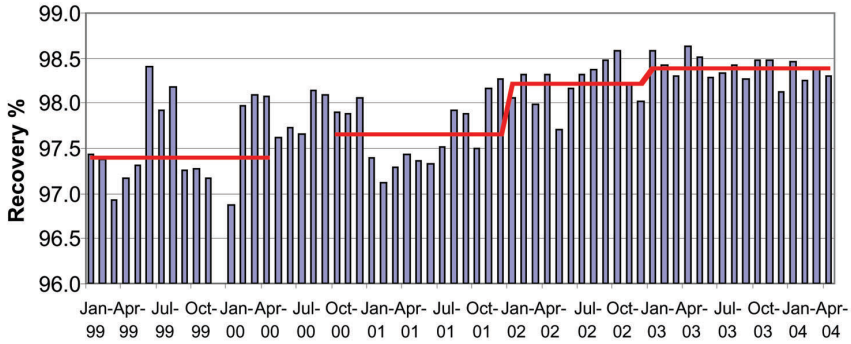

Figure 8—Total plant recovery, Mponeng Gold Plant

The cost of the OCS software installation was approximately R600 000. An additional R600 000 was spent on instrumentation. The 0.4% improvement in gold recovery resulted in a payback of 3 months.

Kopanang Gold Plant[10]

Kopanang Gold Plant treats ore from two shafts, viz. Kopanang and Tau Lekoa. The gold plant is completely 'twin-streamed' and no cross-contamination of the two ores is possible. There are 3 SAG mills dedicated to each stream. OCS was installed on the Kopanang Plant mills during the second half of 2003, and Tau Lekoa mills at the beginning of 2004. Comparative results were only available for the Kopanang Plant mills for this paper.

Table III shows the results achieved from the Kopanang Plant OCS installation. The gradings improved as a result of improved mill mass and discharge density control. Much attention was also given to the cyclone control loops to ensure optimized leach feed. The %+150 micron material decreased by an (absolute) average of nearly 10%. The improvements in circuit stability are attractive, and an example of the current control is shown in Figure 9.

Figure 9 shows that the mill mass variation is less than 1% (by volume), which equates to roughly 3 tons. Based on the stability requirements stated earlier, Figure 5, it is clear that the mill mass is operating consistently in the desired stable control regime.

Figures 10 and 11 show the improvements achieved on mill 5 in the Kopanang Plant circuit. The grind improved significantly and resulted in a greater degree of gold liberation.

Figure 12 shows the washed residue values for Kopanang Plant before and after the OCS installation. The plant recovery was not used to quantify the improvements in performance due to the fact that a new accounting method was implemented during the project. The washed residue values therefore illustrate the improvement in plant efficiency more accurately. The reduction in residue gold content resulted in a payback period, of the OCS system, of 6 months. The fact that the returns were slower than at Mponeng Plant could possibly be attributed to the fact that the Mponeng ore has a steeper grind-recovery curve.

This demonstrates that the benefits from a finer grind have a greater impact on gold recovery. It must also be noted that the Mponeng Plant grind is well below 1% < 150 micron, which will also play a major role in improved recovery.

Table III

Kopanang plant data, before and after OCS

	Mill 4	Mill 5	Mill 6
Average Tonnage			
January 2003–September 2003	98.3	98.4	95.0
October 2003–February 2004	95.2	93.3	94.2
Difference	-3.1	-5.1	-0.9
Average %+150			
January 2003–September 2003	1.92	1.95	1.55
October 2003–February 2004	1.76	1.66	1.45
Difference	-0.15	-0.29	-0.10
Average %-75			
January 2003–September 2003	75.0	75.7	76.8
October 2003–February 2004	76.3	76.6	77.5
Difference	1.27	0.87	0.67

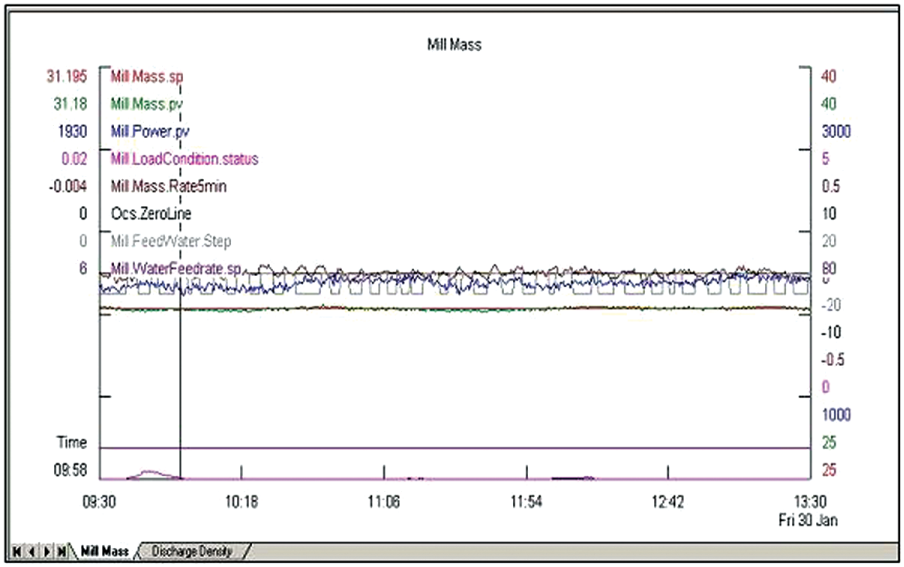

Figure 9—Very stable mill mass control at Kopanang Gold Plant

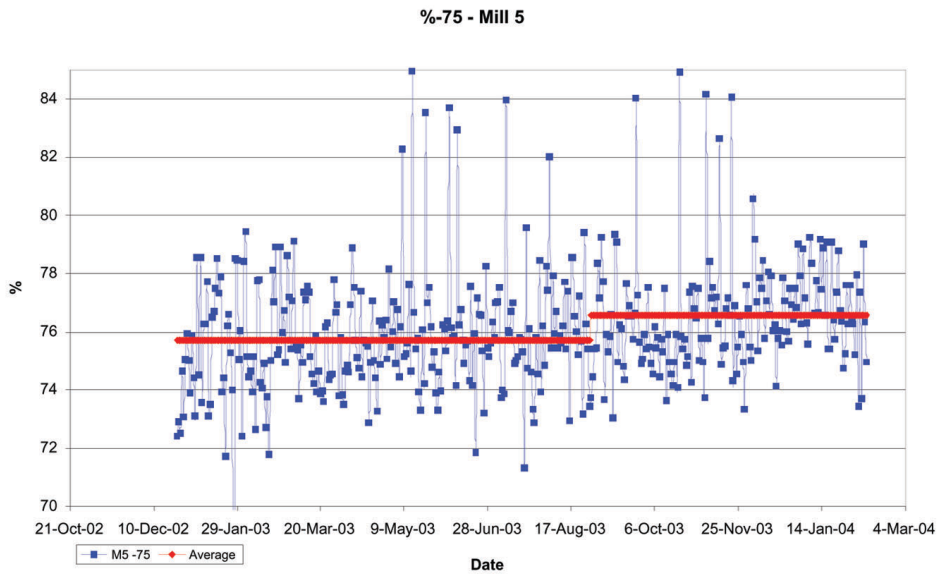

Figure 10—Cyclone O/F % < 75 micron, Kopanang Gold Plant

In summary, the installation of expert control systems has generated the platform upon which the stability of a grinding circuit can be enhanced. Stability is a prerequisite for finely tuned control and allows one to operate one's circuit at optimized set-points for greater proportions of the total running time. In addition to these benefits, improved load control has also reduced the number of mill stoppages that are normally required for the tightening of loose liner-bolts. Mill availability has therefore improved with this reduction in the number of interruptions to the steady operation of the circuit.

Future considerations—product PSI versus feed PSD

Current expert control systems are able to optimize the mill load conditions based on data concerning the breakage characteristics of the mill feed. This can be done in two ways. Firstly, a 'PSD (particle size distribution)' system can be installed to measure the mill feed particle size distribution, and possibly also recognize the proportion of harder and softer materials. Secondly, a 'PSI (particle size indicator)' can be installed on the cyclone overflow stream to measure actual product size distribution. Using the breakage model on the milling circuit, the breakage parameters can be corrected to match the measurements from the PSI. The high cost of these instruments poses the question: 'when and where is a PSD unit more appropriate than a PSI, and vice versa?'

The following questions need to be considered. How significant is the characterization of the mill feed breakage rate on the performance of the control system? To what

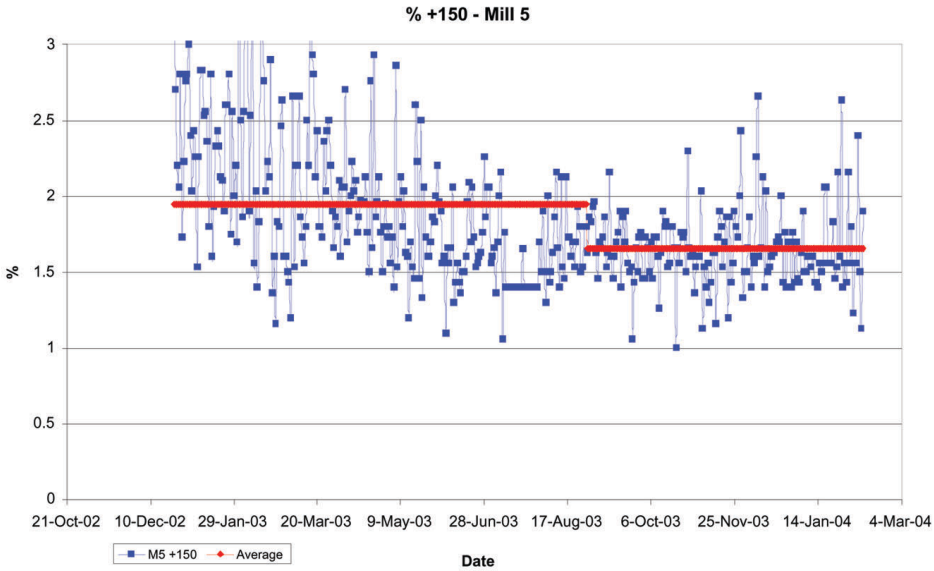

Figure 11—Cyclone O/F % > 150 micron, Kopanang Gold Plant

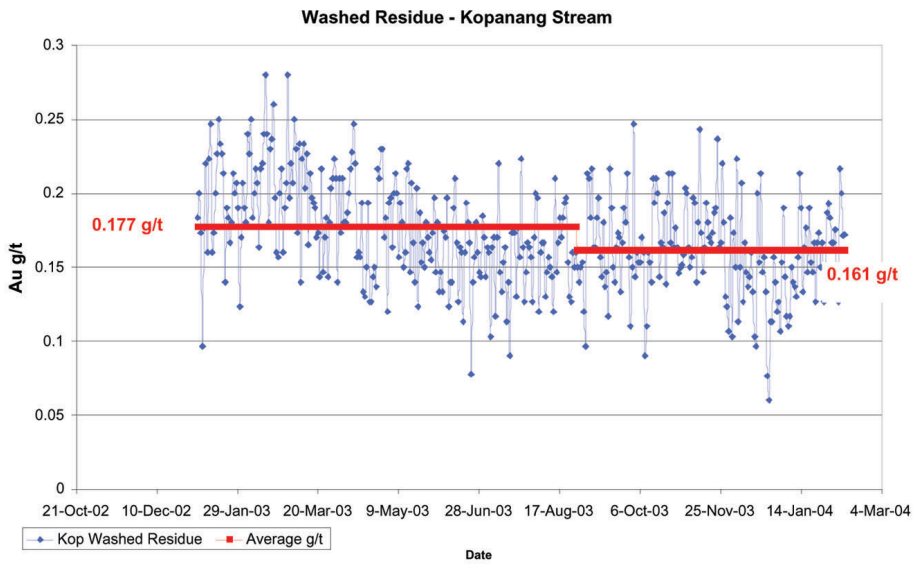

Figure 12—Washed residue Au g/t, Kopanang Gold Plant

degree does the mill feed size distribution affect the performance of the particular mill? How often is the mill feed breakage rate likely to change and is it then possible to control/blend ore types? How good is the available PSD and PSI equipment?

It can be assumed that the equipment has been tried and tested in metallurgical plants. The Outokumpu PSI has been very accurate at the Mponeng Plant site. The Splitt-Online PSD system has been developed with the JKMRC and has also shown good results. To answer the question regarding the importance of breakage rate data, the following literature is considered.

Bouajila *et al.*[11] performed extensive test work at QCMC to determine the effect of feed size on AG/SAG milling. They conclude that the AG mill performance definitely depends on the feed top size to a greater degree than the SAG mill. It is implied that blending (from various stockpiles) is the control step required to optimize mill feed top size. Similar sentiments are shared by Girdner *et al.*[12] who discuss the success of the Splitt unit at Barrick. Morrell and Valery[13] show that as the mill F_{80} increases, so does mill mass. The control response is thus to reduce throughput—suggesting that SAG mills prefer finer feeds than AG mills.

SAR Metallurgy mills are generally silo fed, thereby not allowing mill feed size optimization through blending. 'Mine-to-mill' (blasting) optimization could assist the gold plant as far as size is concerned, but has not yet been considered as a likely option. The fact remains that, in some plants, the breakage rate of the mill feed is likely to change due to reef:waste ratios from mining and rock-dump reclamation.

Mill-silo segregation also precludes direct control of the blend. In the case of these uncontrollable changes, it is still useful to have some idea of the breakage characteristics of the mill feed. The PSI is therefore considered to be the most appropriate instrument on existing plants that do not have the ability to blend variable mill feeds.

Holistic process control

The major cost drivers in a comminution circuit are power and steel. The optimization of the use of power utilizing all the methods described in this paper, is desirable. The performance of the controller can be affected by external factors. The method of steel ball addition plays a role in a number of ways. If balls are added once per day, the steel load in the mill will spike and then decrease dynamically until the next addition. The load models used in an expert control system rely on a steady-state steel load. Discrete ball addition therefore affects the power draw and results in error in the load calculations. If *x*-tons of steel are added instantaneously, the mill controller will reduce the load-ore mass by x-tons in response, which corresponds to an appreciable volume of ore. Another aspect worth noting is that a large, once-off ball addition will also initially result in more ball-ball collisions, increasing the likelihood of ball breakage. It therefore makes sense that continuous steel ball addition will reduce ball consumption and enhance the quality of load control. Automatic/continuous steel ball addition has recently been installed at Kopanang Gold Plant, on two of the six mills. Preliminary results are encouraging.

Another aspect regarding the reliability of the expert control system is the condition of the instrumentation. Two crucial measurements that can experience significant drift and affect production performance are the mill mass signal, whose calibration is often overlooked, and the cyclone feed densitometer. Experience shows that calibration drift tends to occur with these units, and it is up to the metallurgist on site to be highly conscious of such events. OCS has been specifically configured to validate instrument data only if it falls within a realistic range, but minor drifts can still occur within these ranges to affect fine-tuning.

Conclusions

The closed comminution circuit has been considered to be complex and interactive. Advanced control systems provide an opportunity to deal with this complexity, significantly improving control. The benefits of expert control when compared to that of PID control have been seen in grinding and recovery efficiencies. The reduction in mill over/under-load events will also benefit the long-term mechanical integrity of the mill shell and drive components.

The importance of circuit stability is stressed in mill control literature and supported by this paper. The control systems at Mponeng and Kopanang gold plants have been paid back in six months or less, which is reflected in the recoveries achieved.

Finally, poor process control is expensive. It is important to realize that control of any continuous process extends beyond the control system. The holistic approach not only ensures that the controller has the best possible data to work with, but additional benefits can be realized—as is the case with steel ball consumption at Kopanang Gold Plant. The financial benefits associated with the implementation of expert control within AngloGold Ashanti SAR Metallurgy have been demonstrated without exception where this technology has been introduced. The success achieved in mill control has prompted the trial-installation of advanced control on the treatment section of Mponeng Gold Plant. Mintek's Plantstar control system will be used in this regard.

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