

Take control in minerals processing and boost profits

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Although advanced process control or expert control has existed in the minerals processing industry for years, many of these advanced process control solutions have promised much but delivered little.

This was often due to the fact that a specialist was required at site to maintain the advanced process control solution.

There is now advanced process technology (APC) available that ensures better plant performance, reduces downtime and delivers higher profitability without the need for site-based maintenance. The primary objectives of the latest APC technology is to avoid abnormal process situations, reduce energy costs and maintain or improve product quality – benefits that offset the risks of rising costs, lower ore grades and volatile commodity prices.

Rather than simply using one technique to create an advanced control solution, multiple control techniques are now combined to create hybrid solutions. In this way, the appropriate technique

can be applied to the part of the process that it is best suited to control, thus resulting in an optimised and robust solution. For example; model predictive control, recognised as one of the more powerful techniques in a toolbox, can be very successful when used to model a multi-input, multi-output process to create stable process control.

The effectiveness of APC solutions can be further improved through integration of these systems with advanced instrumentation. This comprises acoustic or optical hardware coupled with software that analyses the captured data. They are developed to measure and interpret key process characteristics that are either impossible for a human operator to gather by sight or sound or too dangerous to physically access.

For example; impact analysis of the tumbling charge in large semi-autogenous grinding (SAG) mills, using acoustic sensors, helps prevent damaging ball strikes on liners. Similarly, flotation froth image analysis uses complex algorithms to interpret mobility, stability, colour, bubble size

and texture characteristics to optimise the flotation process.

Smarter computing

APC systems are much more than small control blocks programmed into the plant controller or PLCs. The process analysis, modelling and resulting control actions provided by an APC system require a significant amount of computer processing power. Modern APC solutions comprise a dedicated computer with software that is constantly communicating with the overall plant supervisory control system. APC applications consist of mathematical process models designed to mimic and predict the process reaction under different conditions (Figure 1).

The predictive capability of these systems enables the use of historical data to anticipate future process reaction and provide control adjustments to maintain optimum process control 24/7. In a grinding circuit for example, advanced process technology can analyse a range of signals and actuate automatic adjustments to manage the equipment and process performance for greater efficiency.

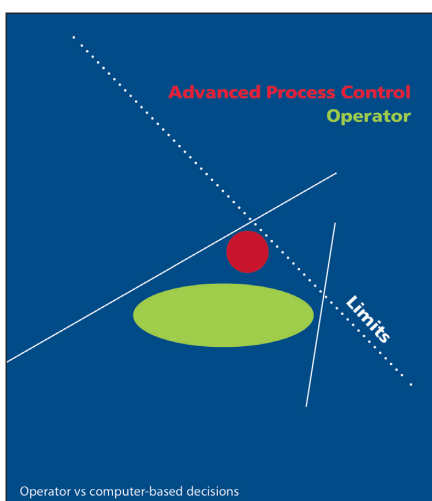


Figure 1. Advanced process control applications comprise mathematical process models designed to mimic the process and to predict process reaction under different conditions.



Figure 2. Human operators often choose conservative parameters due to the inability to analyse the multi-input/multi output control requirements quickly enough on a constant basis.

Changes in process conditions in a typical minerals plant often result in variable flow through the circuit, causing delivery of material that is inconsistent with the required target particle size. This unstable performance reduces the efficiency of the minerals liberation in the downstream processes resulting in lost revenue.

APC technology continuously monitors operational and process conditions. It makes constant automatic adjustments necessary to both stabilise the process flow and balance the load between circuit equipment. This ensures that the circuit delivers a product that matches the required quality whilst the equipment continues to operate in safe condition.

Improved mill circuit grinding efficiency leads to improved energy consumption and throughput. Improved circuit operation together with the increased equipment protection converts to less plant downtime.

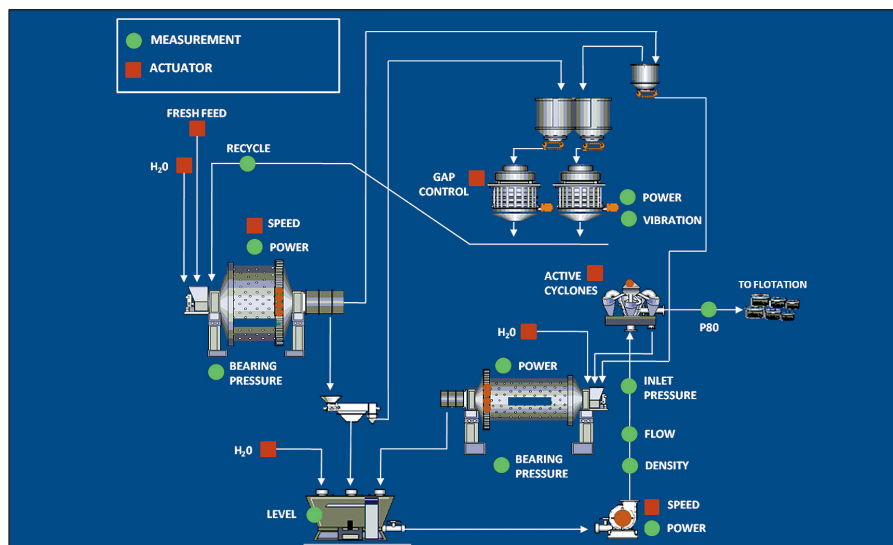


Figure 3. Typical measurements and actuators include circuit feed rate, mill speeds, mill power, mill mass, mill and sump water addition, sump levels, pump speeds and power, cyclone feed pressure and density, and cyclone overflow particle size analysis.

When human operators make adjustments – whether to the mill speed, pumps, water intake or conveyors – they often choose conservative parameters due to the inability to analyse the multi-input/multi-output

control requirements quickly enough on a constant basis (Figure 2).

Depending on what measurements and actuators are available, just about every key process variable can be controlled



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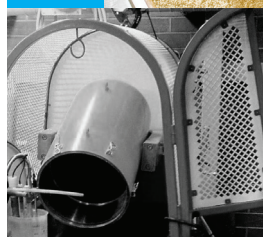
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SHAPING A WORLD OF PERFORMANCE

The need for eco-efficiency in comminution

by Laurie Reemeyer MAusIMM, AMEC Americas Ltd, member of The Sustainability Committee of The AusIMM

In the majority of hard rock mining and processing operations, comminution, that is the process of breaking ore through blasting, crushing and grinding, consumes the majority of energy expended to produce mineral products.

Energy demands

In recent decades mining companies have been faced with declining head grades and increasingly complex ores. Major copper producers in Chile (the world's largest producer of primary copper) have shown a trend of falling copper feed grades in recent years. For example, the copper feed grade at Escondida, the world's largest copper mine, declined by about 40 per cent from 2007 to 2011 (Farchy, 2012). This has led to a trend of larger ore throughput to produce the same quantity of metal product, often resulting in higher energy requirements per unit of final product. In addition, some complex ores have required finer grind sizes ahead of mineral separation stages in order to recover marketable products at

economically acceptable recoveries. Water shortages in several of the major mining regions of the world (eg Australia, Chile and South Africa) have also lead to significant economic and environmental burdens to provide this essential input to mining operations (eg desalination plants, pumping facilities, etc).

Comminution

Comminution is a process that starts in the mine and ends with a product of a required size for processing. Comminution energy includes all energy directly consumed in size reduction as well as energy consumed in the manufacture of comminution consumables, especially steel grinding media and liners. The target size from comminution processes may also have impacts on the costs and environmental impacts associated with downstream processes such as dewatering and tailings disposal. In turn, these interactions may result in an effect on the quantity of water required for mining and processing operations.

Co-efficiency

Eco-efficiency is the 'delivery of competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing environmental impacts of goods and resource intensity throughout the entire life-cycle to a level at least in line with the Earth's estimated carrying capacity' (World Business Council for Sustainable Development, 1992). In the context of comminution, this means designing the system to minimise consumption of energy, comminution consumables and water.

Mine to mill optimisation

Energy efficiency is often not identified as a major factor in determining project value. This is often due to greater economic drivers from other project parameters such as metal prices, throughput and economies of scale to reduce operating costs. However, in some regions, lack of access to infrastructure, reliable energy sources and water is shifting the economic

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by an APC system. This includes circuit feed rate, mill speeds, mill power, mill mass, mill and sump water addition, sump levels, pump speeds and power, cyclone feed pressure and density, and cyclone overflow particle size analysis (Figure 3).

Greater control and performance

An APC system that is well designed and implemented delivers a robust and highly-utilised application. The industry utilisation benchmark for advanced process control is around 90 per cent, with many systems today failing to attain this benchmark.

However, if executed appropriately it is possible to achieve previously unheard of utilisation factors of 95-97 per cent. In addition, very little ongoing tuning is required. There are examples of installations where the system has run at more than 95 per cent utilisation for more than a year before it required any adjustment to the process strategies set up for control.

It's important to understand that today's advanced process technology does not prevent or decrease capital expenditure because it is complimentary to equipment and not a replacement for equipment. However it does contribute to the protection of equipment which can lead to reduced maintenance costs and prevent unscheduled downtime.

An example of this is ensuring that a SAG mill is not run under a suboptimal load that allows balls to damage liners. Similarly, a pump is managed at a more constant speed reducing impeller wear.

In terms of efficiencies, APC has the potential to deliver improved process stability; leading to improved grade or recovery, reduced energy consumption, higher equipment availability and lower maintenance costs.

Advanced process control also facilitates freeing up operator time allowing them to complete many of the additional tasks that are hindered through continuous process control duty. ■