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Particle Size Tracking System vs. Traditional Measurement Techniques

By Dylan Cirulis

Minerals processing plants typically use grinding mills in closed circuit with hydrocyclones to produce a product with a specific particle size distribution for optimum downstream process recovery. Existing instrumentation that provides particle size measurement is considered standard in most modern concentrator plants. However, instrumentation availability is often very low, mainly owing to high maintenance requirements of the analyzer and associated sampling system.

A novel and robust technology has been developed that provides a highly reliable and low maintenance system for online measurement of the particle size in the overflow of individual cyclones. The system is based around a wetted sensor design with no moving parts and provides a real-time trend of the desired target grind size parameter, such as a percentage retained on screen (e.g., % +100 mesh). The system does not require sampling and associated sample transfer piping that is prone to plugging, thus avoiding high maintenance requirements.

The CYCLONEtrac Part Size Tracking (PST) system differs from the traditional particle size measurement approach in a number of ways. Table 1 outlines some of the key differences between the available technologies used for particle size measurement in comminution circuits.

It was developed to bring a particle size measurement solution to comminution circuits. A demonstrated combination of high online availability and fast update rate enable closed loop control of the circuit product.

Benefits of Controlling Particle Size

The particle size of the product stream from the grinding circuit is a critical key performance indicator (KPI) because it is directly linked to the mineral recovery, grinding efficiency and overall plant throughput. There exists a trade-off between the circuit input (i.e., fresh feed or throughput) and the circuit product (i.e., cyclone overflow particle size). With the development of PST comes the commercial availability of a robust online particle size measurement allowing for the development and optimization of particle size control schemes that can take advantage of this trade-off within the circuit constraints.

A large concentrator recently developed a new multivariable control scheme using PST. Grinding efficiency is maintained by holding the particle size and ball mill power within a desired range through manipulation of the cyclone feed percent solids.

Figure 1 shows an example of the variables under control and their set points/ targets.

A recent paper* describes the case study and control in more details. Using a PST-based control scheme, the operation was able to demonstrate:

- Up to a 4.5% reduction in particle size at the same throughput.

Table 1—Particle Size Measurement Technology Comparison

Feature	CYCLONEtrac PST	Traditional Consolidated Cyclone Overflow Measurement Systems Using Calipers, Ultrasonics, or Laser Diffraction	Laboratory Sieving
Update Rate	4 seconds	3-9 minutes	Typically 2 hours with 12-24 hours latency
Enables Sustainable Closed Loop Control	Yes	No, (typically limited by system availability and data latency)	No
Full Stream Analysis	Yes	No	No
Sampler Free	Yes	No	Yes
Availability	>98%	Typically low, with exceptions	High
Number of Particle Sizes Reported[a]	The one key particle size needed for control. (2 or more possible in future)	Multiple[b]	Multiple[b]
Calibration Frequency	One time	Continuous	N/A
Performance Monitoring of Individual Hydrocyclones	Yes	No	Possible but not typical

Notes:
a. The majority of control systems today utilize only one particle size as an input.
b. Multiple sizes typically include one size reported to the control system, the rest for general reporting and process monitoring.

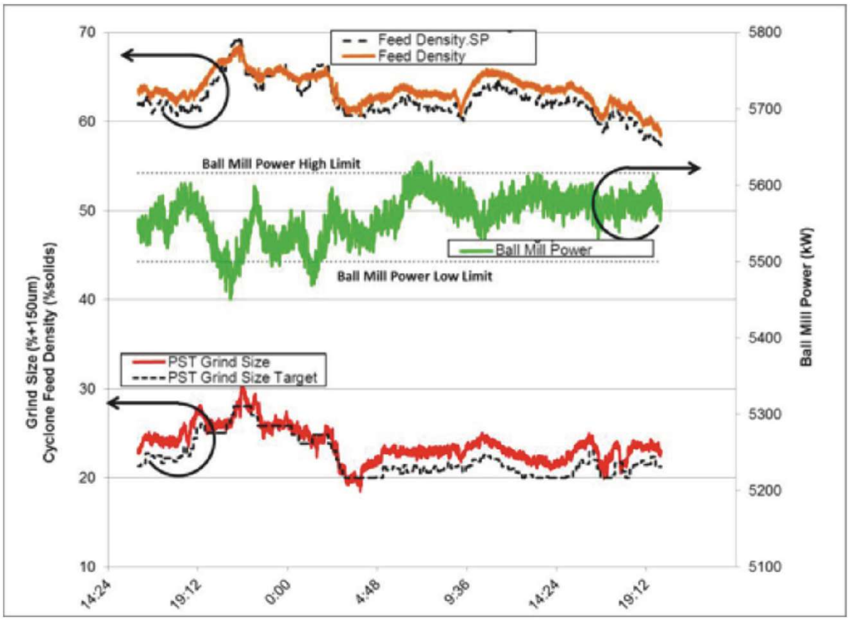

Figure 1—Example of PST-based control.

• Up to 10% increase in throughput at the same particle size.

Benefits of Measuring Individual Cyclones

Until now, there has been no instrumentation on individual cyclones, making it very difficult to identify cyclones that are performing poorly and to quantify this effect on the grind-classification process. A single poorly performing cyclone can have a significant impact on the entire grinding and classification circuit and cause severe disruption to downstream processes. The major impacts include, but are not limited to:

• Extended downtime due to cell, slurry line or tank blockages.
• Lost efficiency due to poor coarse particle recovery.

The root causes of these events are varied, but are commonly a cyclone blockage (rubber liner, object) or exceeding the cyclone capacity, which is defined by pressure, flow and the cyclone dimensions. An example of a cyclone (Cyclone 7) entering an out-of-class state following a 10% increase in the SAG mill feed is shown in Figure 2. Due to the short-circuiting of the cyclone feed, the load on the remaining cyclones is reduced, as inferred by the lower particle size product each cyclone produces. Once cyclone 7 is closed, the cyclone feed flow and pressure recover, and after a surge in cyclone pressure, another two cyclones start to perform poorly for 10 minutes after which they are closed.

In addition to out-of-class events like in Figure 2, cyclones in a cluster perform differently under normal operation. This can be due to items such as uneven flow distribution and wear rate variability. PST enables active cyclone control, whereby the optimum particle size distribution is produced by ensuring coarse cyclones are closed.

For example: At a specified time interval, the coarsest cyclone is closed if it is more than 1 sigma above the median PST signal. Simultaneously another cyclone is opened to keep the pressure disturbance minimized.

Data from a concentrator with a known recovery as a function of particle size was used to model the recovery per cyclone as a function of the PST signal. The results of the active cyclone control were then simulated using the following strategy:

1. Every 30 minutes, the coarsest cyclone is closed, if it is more than 1 sigma above the median PST signal.
2. When it is closed, its signal is replaced with the median (i.e., statistically the new cyclone gives the median grind).

The recovery and the copper losses to tails were then recalculated to get approximately $2 million per year in savings with active cyclone control. This does not include the benefits of out-of-class cyclone detection or global particle size control, which can be an order of magnitude higher in value.

Dylan Cirulis is a metallurgical engineer and the CYCLONEtrac product line manager for CiDRA Minerals Processing. His current focus is process optimization using new technology for particle size measurement in comminution circuits. Prior to joining CiDRA, he spent five years with Rio Tinto in technical and operations roles at the Kennecott Utah Copper Concentrator.

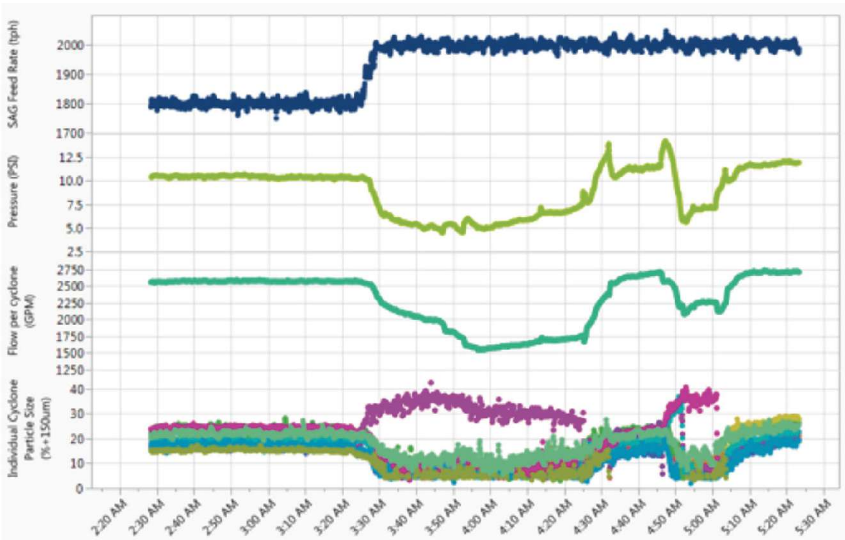

Figure 2—Example of a poorly performing cyclone.

* Cirulis, D., Dunford, S., Snyder, J., Bartsch, E., Rothman, P., Maron, R., Newton, D., O'Keefe, C., and Mercuri, J., *Process optimization using real team tracking of coarse material in individual cyclone overflow streams*, Metplant 2015 Conference Proceedings, Perth, Australia.