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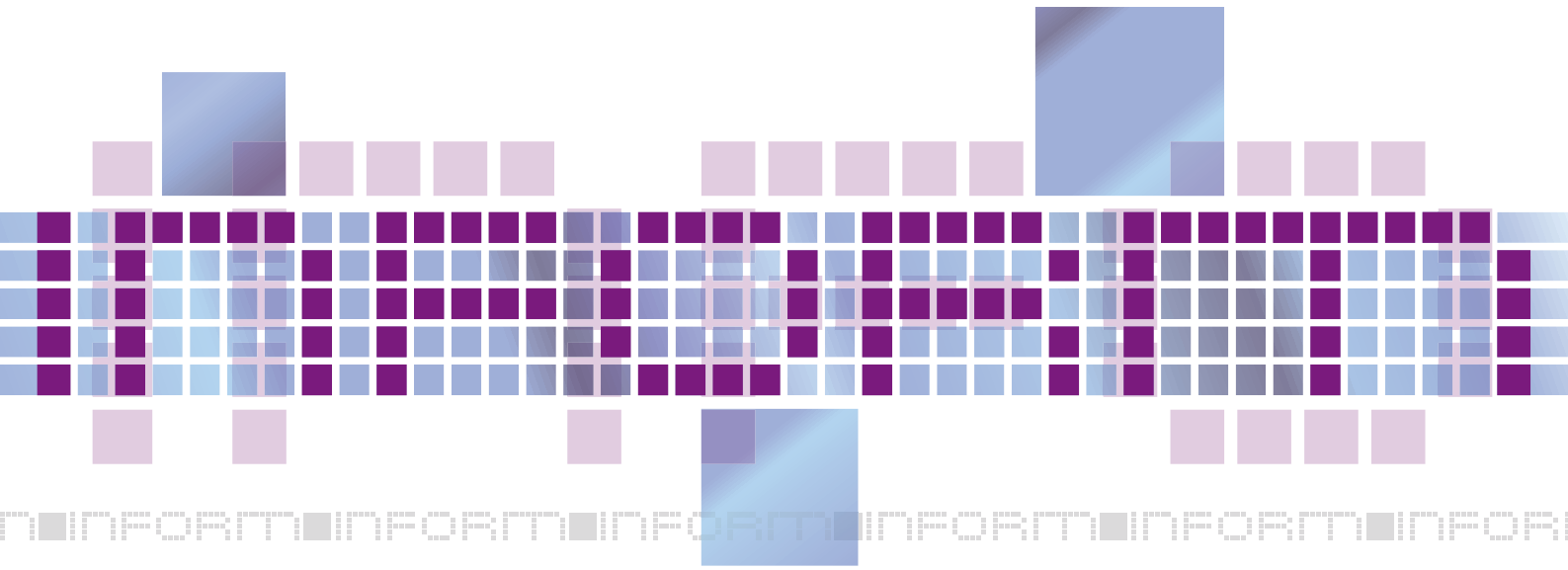

Driving towards manufacturing excellence:

10 reasons to adopt on-line particle size analysis

Malvern

To meet the commercial, environmental and legislative demands of today's marketplace, manufacturers must embrace new, more efficient ways of working. Automation is a recurring theme, of both analysis and control. This INFORM document, one of a series exploring different material characterization techniques, examines the potential of on-line particle size analysis within this context.

1 High return on investment

Justifying an investment in on-line analytical instrumentation relies on having confidence in the technology and being able to make a reliable estimate of the potential gains. With on-line particle size analyzers based on laser diffraction, users routinely report payback times of between six months and a year. Economic advantage flows from many sources: reduced waste, manpower, energy, material, plant capacity; better product quality; automated control; and faster process development and optimization. The detailed case for justification is unique to individual plants but the themes are well understood and common to all. The database of case studies demonstrating benefit, across all industry sectors, grows each year. Consultancy services offering mobile particle sizing technology make it easier to understand the potential for each and every plant.

The risks associated with investing in on-line particle size analysis are low. In the laboratory, laser diffraction particle size measurement has been streamlined over several decades to the point of 'push button' operation. The resulting knowledge base underpins commercially available process systems, which bring the same simplicity to the manufacturing environment. Rugged and robust, these easily installed instruments are specified from the ground-up for reliable, consistent, 24/7 operation, and minimal maintenance. Performance is proven, on applications ranging from sticky wet concentrated slurries to liquid emulsions to dry particulate streams of varying concentration.

Reduced energy consumption 2

The use of on-line particle size analysis to reduce energy consumption is widespread, especially in milling operations.

Milling is highly energy intensive, with energy consumption rising exponentially as target particle size decreases. In many industry sectors - cement, minerals and toners for example - a finer particle size is associated with premium product. Consequently the result of under-milling is often QC failure, while the penalty for over-grinding, excessive energy consumption, is less serious. In plants which are poorly controlled, over-grinding may be accepted as the price that has to be paid for consistently meeting the product specification.

Real-time particle size analysis brings tighter mill control, whether that control is manual or automated: the impact of operational decisions is seen instantly, and they therefore become more effective. The plant steadies and operational confidence grows so that the safety margin provided by targeting an overly fine specification is no longer required. Milling to just the point that gives defined product performance minimizes energy use.

Automated control 3

Automated control, a trend across all manufacturing sectors, demands an appropriate data stream. For very many particulate products, from pharmaceuticals through to metal powders, particle size is a performance defining parameter. For these products, automated control on the basis of real-time particle size measurement is a logical step.

Laser diffraction is a rapid analytical method. On- and in-line systems can measure up to four complete particle size distributions per second and are therefore capable of tracking even those processes that have fast dynamics.

Equally important is the fact that new software is becoming available which eases the integration of a number of analyzers to enable multivariate process control. Packages that adhere to the latest OPC standard for Analytical Device Integration provide a common platform that simplifies the implementation of control strategies based on the measurement of particle size and, for example, composition. This approach allows the operational team to use all available information.

4 Intelligent troubleshooting

Troubleshooting is detective work and its success relies to some extent on the quality of the clues. Comparing real-time measurement with periodic off-line analysis is like comparing video with snapshots. With continuous particle size measurement it is possible to observe the result of every action, intended or otherwise, as it happens - or indeed happened. This is highly valuable when tracing the root cause of a problem and during the evaluation of potential solutions.

5 Fast, effective process optimization

Driving the plant towards an optimal operating point requires command of the levers that influence product performance. The ongoing challenge of manufacture is to meet product quality targets within the constraint of minimizing production costs. For many particulate/solid products, particle size strongly influences performance making it essential to develop a detailed understanding of which parameters affect size and in what way.

Using off-line analysis, acquiring this learning takes a considerable time. A change is made and, eventually, once several samples have been taken and analyzed, the impact becomes clear, provided that all the other variables have been kept constant. In contrast, when real-time measurement is in place, the speed with which new operating scenarios can be assessed is limited only by the time it takes for a new steady state to establish. Changes can be evaluated in minutes rather than hours, and the correlations between cause and effect become both clear and quantifiable. This knowledge accelerates optimization and enables a more intelligent response to unforeseen changes, such as a variations in upstream performance.

Smarter process development 6

Knowledge gathering is a primary function of process development, so here too on-line analysis can play an important role. Compared with full-scale units, pilot plants tend to have a wider operating envelope to fulfil the brief of fully exploring possible operating strategies and find the best way forward. They are expensive to run.

Navigating efficiently around the design space maximizes experimental productivity. Real-time measurement accelerates and improves the knowledge acquisition process, saving time and money. Furthermore, effectively detecting and solving processing problems at an early stage ultimately cuts the time and cost of commercialization. It enables the faster development of better processes.

More complete plant utilization 7

Time spent making out-of-specification product is time wasted. Periods of transient operation can be a particular problem, because it is at these times that it becomes most difficult to control the plant well. If every start-up or product changeover takes longer than necessary then throughput is compromised with each event. For multi-product lines this can be a significant loss.

During start-up or product changeover the aim is to get to the new set point as rapidly as the dynamics of the plant will allow. With on-line analysis in place it is possible to see progression towards this goal in real-time and to rapidly take appropriate control action. The chances of overshoot are much reduced and there is no need to wait for a returned sample to see whether it is safe to switch production to the in-specification collection silo.

8 Instant upset detection

The first step towards rectifying a plant upset is to detect that it has happened. With real-time particle size measurement this occurs instantaneously, and there is the facility to provide a process alarm to alert the operator where necessary. In addition, the rapidity and extent of the change from set point may help with diagnosing the problem.

This is in sharp contrast to a typical situation with periodic off-line analysis where sampling only occurs every hour and it takes 30 minutes for the results to be returned. Here, in the worst case scenario an upset can go undetected for over an hour. Where this is long enough to ruin a batch run or a silo of in-specification product, the effect on throughput and waste is significant.

9 Market-leading product quality

There are two key aspects to product quality. One is setting the specification to deliver optimal performance; the other is meeting it consistently. On-line particle size analysis can address both issues.

Conventional particle sizing techniques often fail to differentiate sensitively between samples. This may be because they are manual and subject to operator variability, for example, or perhaps deliver a single, averaged figure for the sample. The cement industry provides an excellent example of this problem. Here Blaine measurement, a largely manual specific surface area technique, is the traditional choice for product specification/QC. Blaine provides an acceptable indication of product performance but cannot distinguish between samples that have differing particle size distributions and which, crucially, would deliver different performance in the field.

Using laser diffraction particle size analysis, cement industry leaders have found that they can more precisely target key performance indicators, such as early strength, by controlling the proportion of material in different size fractions. For this sector, laser diffraction promotes the development of set points for manufacture that more accurately reflect product performance; and consequently the technique is rapidly displacing Blaine.

For any product, once the optimal specification has been determined, the customer wants material that consistently meets it. In many sectors particle size specifications are becoming finer and attaining premium product status may also require tight control of particle size distribution. Frequently such specifications can only be achieved successfully and economically by using the tight control that real-time process monitoring delivers.

Reducing risk

On-line measurement simultaneously eliminates the health and safety issues surrounding manual analysis, and reduces the likelihood of erroneous data.

Sample extraction and work-up presents a potentially significant health and safety risk, especially where process materials are highly volatile and/or toxic. With a fully automated on-line system this risk is eliminated. Safety is improved and operator time is released for more productive activity. In many instances, this saving in manpower costs is sufficient to justify investment in an on-line system, even without quantifying other economic gains and the benefits of enhanced safety.

Furthermore, analytical data delivered by an on-line laser diffraction analyzer should be of significantly higher integrity than data from an off-line system reducing the risk of incorrect control action. This is because on-line systems:

- Eliminate operator variability – during sampling and measurement
- Measure larger and continuous sample volumes – a vastly higher proportion of the process stream
- Automate the complete analytical cycle

By eliminating the need for manual intervention throughout the analytical process, and dramatically increasing the frequency of measurement, automated on-line analysis delivers the most reliable data stream for efficient process control.

We hope you find '10 reasons to adopt on-line particle size analysis' useful.

This is one in a series of publications designed to help decision makers in your industry make more informed choices.

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