

Real-time particle analysis to optimise grinding

In modern dry grinding operations, precise particle size control is essential for product quality and energy efficiency. However, traditional laboratory measurements often fail to provide the real-time insights needed for fast process optimisation. To meet these demands, CEMTEC developed a particle analysis system that combines advanced laser diffraction technology with continuous real-time monitoring.

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In modern dry grinding operations, consistent product fineness is a critical quality parameter. Variations in particle size distribution (PSD) can impact downstream processes, product performance and overall plant efficiency. Moreover, the increasing pressure to reduce energy consumption and enhance sustainability means that precise process control is no longer optional but essential.

However, traditional laboratory-based particle size measurements are time-consuming and provide only snapshots of system behaviour. In contrast, real-time analysis enables continuous process feedback and rapid corrective actions. This leads to stabilised operations, reduced overgrinding and more efficient use of energy.

To meet these evolving operational needs, CEMTEC developed the CEOPS system, combining high-resolution laser diffraction technology with advanced data integration capabilities. The result is a robust solution that delivers reliable, high-frequency particle size data directly to operators and plant control systems.

Enabling real-time feedback

The CEOPS system is designed for continuous measurement of PSDs in dry grinding processes, with a measurement range from 1 to 2000µm. Developed entirely at CEMTEC's headquarters in Enns, Austria, the system ensures precise and representative sampling, enabling real-time feedback for closed-loop control. At its core is a high-performance laser diffraction unit that performs continuous measurements of the sample stream, enabling operators to detect and respond to process changes in real time. The system

is fully customisable and integrates seamlessly with existing plant control systems through standard industrial communication protocols. The CEOPS Analyzer supports a wide range of dry material applications, including cement, fly ash, limestone, slag and other mineral raw materials. Its modular architecture allows adaptation to various plant layouts and process flows.

System architecture and key components

The CEOPS system comprises five main components, each contributing to its overall precision, reliability and usability.

Representative sampling unit

Available in screw, chute and direct sampling configurations, the sampling unit is designed to extract a consistent and accurate sample from the product stream. Typically installed downstream of the classifier or separator, it ensures that the analysed material reflects the actual process output.

Switchbox

This optional module allows multiple sampling points to be monitored alternately using a single CEOPS system. This is particularly useful in plants with several parallel grinding lines or multiple product streams.

Continuous measurement of PSDs in dry grinding processes is increasingly important and the ceops system is designed to support cement producers in achieving improved process control



CEOPS cabinet

The CEOPS cabinet contains the laser diffraction analyser, integrated air conditioning and a control panel with an HMI display. The system's core is engineered for robust, low-maintenance operation, even in harsh plant environments.

CEOPS control system

The control unit handles data acquisition, processing, and visualisation. Proprietary software enables both on-site and remote access to live data, trends and system diagnostics.

Communication interface

The system communicates via standard protocols such as Modbus TCP/IP, OPC UA, or Profinet, enabling integration into SCADA, DCS, or MES environments. This ensures central visibility and facilitates automation strategies.

Process description

The process begins with the representative sampling device – most often a screw

conveyor – extracting material from the transport line under negative pressure, downstream of the separator. This material is pneumatically conveyed via compressed instrument air to the CEOPS cabinet.

Inside the cabinet, the sample is directed through a venturi system and pinch valve before entering the laser measurement unit. Here, particle size is analysed using laser diffraction, a highly accurate method based on the scattering pattern produced by particles when illuminated by a laser beam. Measurement data are immediately processed and displayed on the built-in HMI screen as well as transmitted to the plant control room in real time. Operators can view current PSD curves, trends, alarms and historical data. Once the measurement is complete, the sample is returned to the product stream via a dedicated return line, ensuring zero material loss. Such configuration prevents from any material spillages, allowing for safe material sampling. The CEOPS system requires only a standard power supply, a LAN connection, and instrument air to operate. Thanks to its intuitive interface and robust design, the system demands minimal operator intervention and routine maintenance.

Key advantages

The CEOPS system offers several benefits that translate directly into operational and financial performance:

- continuous, real-time measurement of particle size distribution
- highly accurate laser diffraction analysis
- representative and consistent sampling
- fast detection of process fluctuations
- improved control of product fineness
- reduction of overgrinding and associated energy costs
- seamless integration with existing plant control infrastructure
- customisable set-up for different materials and flows.

Return on investment and sustainability

One of the most compelling arguments for CEOPS is its rapid payback. Depending on the process and material, the return on investment is typically achieved within 6-12 months. This is driven by lower energy consumption, improved product quality, reduced wear on grinding equipment and higher process stability.

From a sustainability perspective, CEOPS supports more efficient use of raw materials and energy. By avoiding

overgrinding, the system contributes to CO₂ reduction and aligns with industry goals for environmentally responsible production.

Applications

The CEOPS Analyzer has been implemented in a variety of industrial settings, including:

- cement grinding plants using ball mills and roller presses, where fineness and product consistency are crucial
- fly ash classification systems, which benefit from real-time PSD control to ensure compliance with fineness requirements
- supplementary cementitious materials (SCMs) and blended cements, where different materials must be milled to tightly controlled specifications.

In all cases, CEOPS provides operators with actionable data to make information-based decisions. For example, if the PSD drifts outside of target limits, the system can trigger alarms or even initiate automated adjustments via the plant's control system. This capability significantly reduces the need for manual sampling and laboratory analysis.

Case study: cyment, Hungary

CEMTEC recently completed a reference project with cyment Kft, a specialist in Type II SCMs. At its state-of-the-art grinding facility in Mosonmagyaróvár, Hungary, the company produces SCMs with a CO₂ footprint of just 26.2kg/t, 95 per cent below conventional Portland cement. The SCMs integrate directly into existing mixing processes – no adjustments, no added costs – delivering equal or superior strength, greater durability and a fraction of the environmental impact. The company's products enable concrete manufacturers to reduce emissions by up to 50 per cent in finished concrete while maintaining full technical performance specifications across applications in ready-mix, precast and infrastructure projects.



CEOPS at cyment's plant in Hungary

For cyment, consistent PSD and overall fineness are critical to product performance and regulatory compliance. Meeting the defined specification window across all production batches requires continuous monitoring and process control. The combination of AI-supported quality assurance and real-time monitoring through CEOPS enables the facility to ensure specification conformity, optimise energy efficiency in the grinding process and maintain the tight tolerances required for certified sustainable concrete production.

The CEOPS project, consisting of one screw sampler and one measuring unit, was launched at the end of 2024 and successfully commissioned in the 1Q25. The optimal sampling position was identified in the area between an air slide and the finished-product bucket elevator. In addition to process-relevant parameters such as material flow and negative pressure in the equipment lines, space conditions with proper accessibility were also carefully evaluated. After installation and a defined testing period, the measurement results from the CEOPS unit were aligned and correlated with the results from the laboratory laser analysis. Communication and data exchange are facilitated through Profinet, an industry-standard protocol built on Industrial Ethernet. The system is in continuous operation and is regularly used by both the production and quality departments, providing significant added value. Operating alongside the grinding line, it delivers reliable, high-quality data that helps the customer optimise production and ensure both process and product stability.

Plans for a second sampling unit are already well underway and it is expected to be commissioned in the 2Q26.

Towards smarter grinding

As the cement and minerals sectors move toward digital transformation, systems such as CEOPS are becoming central to operational excellence. Rather than relying on periodic laboratory samples, operators are empowered with real-time data that allows them to optimise performance dynamically. Upcoming CEMTEC Digital enhancements include advanced AI-based process optimisation, predictive maintenance modules, and expanded data analytics features. With these additions, CEOPS will not only monitor but also help actively control and improve grinding operations. ■