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Refractory material recycling

Laser-based material analysis for the first time in a mobile system

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The life of refractory materials in furnaces and converters used in the metals industry is limited due to the heavy wear resulting from the exposure of these materials to high temperatures and chemical attack. The recycling of refractory materials removed from the furnaces can dramatically reduce the purchase costs for new linings. As part of its CERO Waste concept for the recycling of refractory materials, MIRECO offers its customers the largely automated MAESTRO recycling system. A central component of the plant is the automatic MopaLIBS material analysis system from SECOPTA analytics GmbH.

The highly compact MAESTRO system can be transported on just four trucks. (Photo: Horn & Co. RHIM Minerals Recovery GmbH)

Worn refractory linings that have been removed from steelmaking furnaces contain numerous valuable raw materials. To save resources and costs, these materials are recovered and returned to the material cycle. This is one of the many contributions made by recycling to green steelmaking and a sustainable economy. Moreover, recycling reduces the dependence on raw material suppliers.

For the production of high-grade recycling products, it is crucial that the materials are properly sorted into the individual material classes during the recycling process. However, reliable detection and classification of the materials by human sorters requires comprehensive expertise: It may take up to tw o years of training until a sorter is experienced enough to achieve high-quality sorting results. Even then, the classification remains prone to subjective influences. Last but not least, sorting the bricks with one's hands is very hard physical work. For these reasons, Mireco has developed systems that sort the break-out material – after it has been stably positioned on a converter belt – in an automated process. Mireco has been using the MopaLIBS (**L**aser **I**nduced **B**reakdown **S**pectroscopy) systems from Secopta for automatic material analysis at its facilities in Siegen for many years. These systems increase the quality, efficiency and throughput of recycling processes, while reducing personnel costs.

Recyclers often collect refractory material over longer periods in order to process it in larger quantities at a later date. The need for refractory recycling equipment is in many cases only temporary and would hardly justify the investment in a stationary plant. Therefore, Mireco developed the MAESTRO (**M**obile **A**utomated **E**fficient **S**orting **T**echnology for **R**ecycling **O**perations) – a highly compact unit that the company has made part of its CERO (**C**ontinuous **E**conomic **R**ecycling **O**ptimization) Waste concept. The first system of its kind was successfully commissioned at the recycling center in Siegen/Germany where it is currently being run in by MIRECO. Subsequently, it will be available for use in customer projects.

The objective real-time analysis of the material flow on the feeding conveyor and the largely automated sorting process ensure a consistently high quality of the recycling product.

The MopaLIBS sensor contains the optics for signal transmission and reception. (Photo: Secopta analytics GmbH)

Precision guaranteed with MopaLIBS

A central element of the MAESTRO plant is the quick and accurate chemical analysis of the material to be sorted by means of SECOPTA's MopaLIBS system. This system automatically analyzes and classifies in real time specific elements of the material on the passing conveyor belt – including magnesium, aluminium, silicon, calcium, iron, zircon and chromium – with very high precision. For its newly developed MAESTRO plant, Mireco decided in favour of the Secopta system because this technology had already proved its worth for many years under rough operating conditions in the recycling of refractory materials and various other industries. A further benefit of the system is that it can be easily adjusted to new sorting strategies by means of individually configurable sorting criteria. Thus, in particular light elements such as magnesium can be analyzed with very high precision.

LIBS systems analyze mineral and metallic materials in an inline process. For the measurement, a pulsed laser beam is focused on the material passing below the sensor on the conveyor belt. This causes small amounts of material to evaporate and form plasma. The bonds of the molecules break as the material transitions into plasma. Free charge carriers are present in their excited state. When the plasma turns back into gas, these charge carriers emit light spectra unique to the respective element. The spectra are evaluated by means of dedicated algorithms. 1,000 measuring points per second are generated for each calibrated element.

Secopta uses low-intensity lasers that operate at very high pulse rates in order to achieve a high energy input. Thus, the sensor can operate with utmost stability, reaching a very long service life at the same time. This considerably reduces the maintenance effort and cuts operating and personnel costs. Therefore, the systems pay off in a very short time, providing operators with a distinct cost advantage.

The compact design of the new mobile MAESTRO makes it possible to transport the entire plant, including the LIBS and the mechanical process equipment, by truck in just four containers. The equipment can be set up and dismantled in two days. The system operates with the same algorithms as those MIRECO uses in its stationary plant. The specially developed and continuously enhanced calibration is based on in-depth expert knowledge. This makes the plant the solution of choice for companies that do not have personnel skilled in material classification … an important aspect with a view to the shortage of skilled labour in the industry.

The first MAESTRO in operation at MIRECO processes bricks between 70 and 300 mm in size. The belt speed is adjustable between 4 and 22 m/min. The recycling material is distributed into eleven sorting containers and four manually operated discharge chutes by means of a rotary chute designed to turn through 180° in just 1.25 seconds. The plant achieves a sorting capacity of up to 36 bricks per minute.

The MopaLIBS sensor is arranged above the conveyor belt that transports the material to be recycled. (Photo: Secopta analytics GmbH)

About Secopta analytics

Secopta analytics GmbH, based in Teltow near Berlin, implements laser-based analysis solutions for tasks in industrial process control and in the production of primary and secondary raw materials.

Application fields for the company's systems range from extraction and refinement of raw materials to process control in industrial manufacturing and processing of secondary raw materials, environmental analytics and detection of hazardous substances. Secopta provides full-line customized solutions for automated analytical processes, including in-line, on-site and in-situ analyses during running production.

The MAESTRO plant in operation at MIRECO's facility in Siegen. (Photo: Horn & Co. RHIM Minerals Recovery GmbH)

About Mireco

MIRECO (MInerals RECOvery) is Europe's leading recycling platform for all players in the refractory industry. Its mission is to promote the decarbonization of the European industries through the provision of effective circular solutions. Together with a comprehensive network of customers and suppliers, MIRECO develops high-quality systems and efficient solutions that help its customers to save CO_2 emissions. This strengthens the circular economy in the European refractory sector and makes an important contribution to a more sustainable industry. As a joint brand of global refractory producer RHI Magnesita and Horn & Co. Group, with more than 100 years of experience in refractories and recycling, MIRECO plays a pivotal role in the development of a circular economy, providing the complete range of services and products for closed-loop raw materials recycling. Each individual recycling concept is tailored to the customers' specific needs and based on the company's CERO WASTE (Continuous Economic Recycling Optimization) approach.

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