Advanced measurement technologies in coke-making and iron-making

Conveyed flow quality measurement in real time provides the next level of plant control where there is higher variability in composition than expected, and analyser experts at Scantech have developed new solutions.

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Material quality variability is a key challenge in process control. Nature has blessed us with mineral and coal deposits, but challenged us with variable quality. Mined material is not homogeneous. Materials handling may mix the more and less valuable components to generate a blend. Actual measurements show that this mixing still leaves considerable variability by the time the material reaches the next stage in the process.

Processing, usually through beneficiation of iron ore and coal, produces a range of products sold primarily to the steel industry to be used in iron-making. Steel companies receive iron ores and coal/coke from multiple suppliers with different composition characteristics and blend this material to feed furnaces to make metallic iron. The main parameter to measure in coke or coal for consistent iron quality is moisture content, assuming ash and elemental content is at specification.

For the iron ore feed, a range of elements and ratios or elements are measured to ensure the correct chemistry to maintain furnace health. Companies recognise that in order to control feed quality, this needs to be measured. Across commodities and regions, it is recognised that this is an area to address in order to do things smarter. Real time measurement is an obvious method to achieve this, with typically short paybacks, sometimes a few months and normally much quicker.

Easily installed

Benefits from measurement are maximised by integrating with existing infrastructure for bulk flows. Scantech has designed its analysis equipment that can be easily installed on conveyor systems, allowing for continuous real-time quality measurement. Conveyors are used throughout mining and downstream processes so there are numerous applications where Scantech's analysers provide opportunities for gains in process control by measuring and reacting to changes in material quality in a timely way.

Measuring material characteristics in hoppers is known to be problematic, with few measurements being representative and some instruments interfering with flow and even causing hang-ups and blockages. Measuring continuously through conveyed flows has proven to be a representative way to determine and allow effective control of material quality. Measurements are transmitted to a plant control room where responses can be actioned when needed.

GEOSCAN-M is a high-performance elemental analyser utilising Prompt Gamma Neutron Activation Analysis (PGNAA) to measure the elemental composition continuously in real time, through the full conveyed cross section so that the entire flow can be representatively measured over short time increments.

It utilises a californium-252 source to excite the elemental nuclei in the conveyed flow with neutrons, which in turn emit gamma rays that are detected by a high-specification detector array above the conveyor, allowing individual elements to be measured directly and independently. This configuration, combined with proprietary software, yields measurement performance that is unmatched in the minerals industry.

The GEOSCAN-M is combined with Scantech's TBM microwave moisture analyser (on suitable materials) and takes an input signal from a belt weigher to provide tonnage-weighted average dry basis elemental and moisture results over a short analysis period to the plant control system. The GEOSCAN-M, already the highest specification PGNAA system available, can be configured to measure over shorter or longer time increments depending on the application. Where bulk sorting is required, short analysis, say every 30 seconds, allows for a minimal sorting increment mass, whereas for blending purposes a longer measurement time of say five minutes may be appropriate.

Typically results are reported every one or two minutes with high accuracy due to the customised calibration for each material and application. The GEOSCAN-M has a patented 'no belt contact' design and has 'no wear' components, ensuring minimal maintenance requirements as well as complete safety through careful design of the shielding and access. Typically no isolation area is required around the GEOSCAN-M during normal operation.

Elemental technology

COALSCAN 9500X is the elemental technology equivalent to the GEOSCAN-M and can be used for blending coals prior to coke-making to ensure that elemental and ash content is controlled. The ash content is measured to a better than 0.5% total ash accuracy and individual elements such as sulphur, iron, calcium and others are

GEOSCAN-M - elemental analyser for iron ores and sinter.

Photo: Scantech

measured accurately based on the customised calibration for the composition ranges expected.

It is also used in the coal industry for managing ash and sulphur content in thermal coal to improve environmental compliance of boilers. High and low sulphur-containing coals are analysed and diverted to appropriate bunkers based on their composition. Boilers with flue gas desulphurisation can burn a higher sulphur-containing coal. As well as the improved energy recovery from blended coal feed, the real time analysis also results in improved environmental compliance and reduced sulphur dioxide emissions to the atmosphere.

TBM and CM100 Moisture measurement options allow most materials to be measured. Most iron ores can be measured using a TBM microwave moisture analyser, typically to accuracies better than 0.5%. Attenuation and phase shift are measured using microwaves transmitted through the full conveyed flow depth to indicate the presence of free moisture in the material. Moisture content can also affect the process performance and measurement may also assist with dust management or dry tonnage basis calculations. In magnetite iron ores and concentrates, a radiation-based technology utilising fast neutrons and gamma transmission may be required if the TBM microwave technology is not suitable.

The CM100 effectively measures the hydrogen content directly to enable moisture measurement to accuracies of better than 0.3% moisture over each measurement interval of a few minutes. Moisture analysis technologies are particularly useful for monitoring iron ores during loading onto ships where TML (transportable moisture limit) is useful to monitor. While not used for moisture certification of a shipment, the real-time analysis technologies are beneficial in detecting when material quality changes during the loading process and alternative actions are required to prevent the specification being infringed. It may require material to be sourced from a different stockpile or loading to be interrupted or even stopped to prevent the ship having to be unloaded again.

Moisture content also determines energy consumption in removing the water fraction. In coke-making this water is evaporated in the process. However quench water is added to the coke and its content is variable, so measuring the moisture in the coke is valuable in controlling the carbon-to-iron ratio in furnace feed. Coke is very light relative to water, so small variations in moisture content can significantly affect the weight of wet coke being measured.

Blending

Blending is managed using elemental measurements of the conveyed iron ore or coal and adjusting the proportion sourced from different quality ▶

Real time conveyed quality measurement:

- GEOSCAN-M elemental analyser for iron ores and sinter
- COALSCAN 9500X elemental analyser for coal
- TBM200 series microwave moisture analysers for iron ore and coal
- CM100 moisture analyser for coke and magnetite

Photo: Scantech

GEOSCAN-M installed on iron sinter feed, with TBM moisture analyser installed in foreground.

stockpiles. Where stockpiles are created using a GEOSCAN-M, the quality will already be known with a high level of confidence. Adjusting the blend in real time allows a more consistent feed quality to the process plant, improving its performance, as high variation leads to process inefficiencies. COALSCAN 9500X has been implemented in a steel plant's coke-making area to blend coals from different sources for improved coke quality.

Sintering is a classic blending application where elemental analysis of the sinter for its key components, such as Fe, Ca, Mg, Si, Al, P, C, etc, can be used for blending control upstream of the iron ore raw materials, and importantly for basicity control through correct and precise limestone addition. A number of iron-making plants in Europe are utilising the high specification GEOSCAN-M to measure these elements with high accuracy and controlling sinter chemistry to within a narrow composition range to achieve optimal energy consumption, iron quality consistency, low basicity variation, and furnace availability.

The loss of control in sinter chemistry has been known to result in frozen furnaces and significant costs in furnace remediation work with downtime from lost production also costing millions of dollars per day. The addition of an analyser and improved sinter quality management can eliminate this risk. In such cases analyser payback can be measured in hours or even minutes.

Plant performance

Plant performance can be improved through raw material quality measurement for feed forward control. Plants perform most efficiently when a consistent quality feed material is provided. Knowing when there is a major change in quality before it arrives in the process is useful for ensuring appropriate control systems responses. These may include controlling feed rates based on ore quality changes or additive control where applicable. Analysers are designed to require minimal maintenance and have robust design and hard-wearing finishes. They are non-contact, have minimal moving parts and 'no wear' components and don't interfere with the conveyed flow or conveyors. Remote access is standard in each system to minimise site visits which further reduces operation expenses.

The spectrometer-based systems require some ongoing support through half-yearly calibration reviews and fine-tuning. Some radiation sources require supplemental sources each two and a half years to maintain the high measurement capabilities. Operating costs are typically below one cent per tonne of conveyed material measured. GEOSCAN-M technology can also measure elements for quality management by using proxies for elements that occur at levels too low for direct measurement by GEOSCAN-M or that are not suited to PGNAA – but that is another story. ■

LATEST NEWS!

- GEOSCAN-M is now installed in the following commodities: iron ore and sinter, Mn, Cr, Cu, Ni, Zn-Pb, phosphate rock, Li, bauxite, and Pt and can now measure gold directly on the belt in conveyed material. Please ask us!
- Scantech will be exhibiting at AIST in Cleveland in May 2020 as well as many minerals, coal and cement events globally