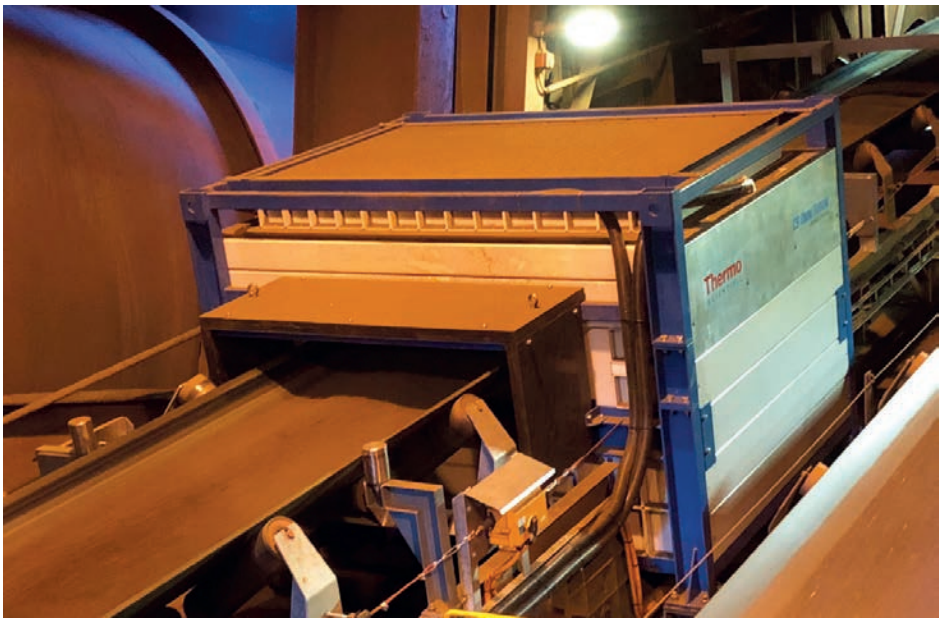
Improving sinter feed analysis

Hüttenwerke Krupp Mannesmann GmbH (HKM) in Duisburg, Germany, a subsidiary of Thyssenkrupp Steel Europe AG, produces up to 5.1Mt/yr of sinter and 5.4Mt/yr of steel. Six years ago, the company upgraded to an online sinter feed analysis system that uses prompt gamma neutron activation analysis (PGNAA) to determine elemental concentration in bulk materials. Overall, HKM saw a return on investment in less than a year. By **Kevin Gordon**[1] and **Bernhard Oehling**[2]



A KEY determinant of steel quality is the quality of the sinter feeding the blast furnace. For steel manufacturers, controlling the chemistry and minimising the variability of the sinter feed mix is a fundamental requirement. Sintering process fluctuations, inhomogeneous mixtures and other factors can negatively affect physical and metallurgical quality, impede stable furnace productivity and drive up raw material and fuel consumption and costs. But maintaining optimal composition and basicity using the traditional lengthy, laboratory-based sinter analysis process is both challenging and inefficient.

Increasingly, leading steel manufacturers are relying on online instrumentation that uses an innovative application of prompt gamma neutron activation analysis (PGNAA) technology to help them validate the composition and quality of sinter more effectively and efficiently.

Sinter quality challenges

Proper selection and mixing of the raw feed materials is only the first step in ensuring high quality sinter. The variability of the raw materials' chemistry both within and between batches means that the sinter feed mixture's composition and basicity must be constantly monitored, analysed and adjusted for conformity and stability. Typically, the chemistry is controlled based on incremental collection and laboratory analysis of composite samples of the final sinter product. Because of the multi-hour lag time from sample collection to completed lab analysis, the resulting adjustments to composition, proportions and basicity affect sinter being produced hours after the samples were collected. If sampling is not done frequently enough, short-term variability in sinter composition will be missed, smoothing out and hiding the true process variability. As a result, process upsets and missed chemistry targets in the sinter feed are unknowingly passed along to the blast furnace.

The power of PGNAA

Hüttenwerke Krupp Mannesmann GmbH (HKM) in Duisburg, Germany, is a subsidiary of Thyssenkrupp Steel Europe AG that produces up to 5.1Mt of sinter and 5.4Mt of steel per year. Six years ago, HKM upgraded to a Thermo Fisher Scientific online sinter feed analysis system that uses PGNAA to determine elemental concentration in bulk materials. This neutron activation analysis technique works by bombarding materials with neutrons that interact with elements in the materials, causing those elements to emit secondary, prompt gamma rays that can be measured. Each element emits a characteristic energy signature as it returns to a stable state, allowing the analyser to determine its elemental composition.

This non-contact, non-destructive method measures through many centimetres of material, so it's ideal for real-time analysis of bulk materials on conveyor belts. Because the entire process stream is analysed, the errors potentially associated with mechanical sampling of the final sinter product can be reduced.

This online analysis system has allowed

1. Thermo Fisher Scientific. 2. Hüttenwerke Krupp Mannesmann GmbH

HKM to validate sinter composition and quality more efficiently and cost-effectively. Instead of taking hours from sample to result, we now see chemistry information each minute on a real-time basis, enabling plant operators to make quicker, better informed decisions to control the basicity of the sinter.

Boosting quality, uniformity and efficiency

Thermo Scientific's CB Omni online elemental analyser uses PGNAA technology to deliver a combination of real-time analysis, full process stream analysis and accurate and reliable elemental analysis. For HKM, the biggest advantage has been faster analysis. HKM's old analysis method involved a very long waiting time while the sinter cooled, and several samples were collected and sent to the lab for composite analysis. As a result, it would take five to six hours from the time a change in the mix proportion occurred to when the change in the analysis could be seen. HKM acquired the PGNAA analyser to significantly shorten that multi-hour lag time. Now the company can react much faster when switching between different mixed compositions and where input materials fluctuation occurs. The PGNAA is located between the mixing drum and the sinter strand. We know, therefore, the composition of the sinter before it is produced. This helps to shorten response time. Today, HKM's mean response time is approximately 30 minutes.

The overarching goal for sinter plant operators is achieving a high output of uniform sinter quality at low operational costs. For HKM, the sintering process has become significantly more uniform, which has translated to higher performance. PGNAA analysis allows the company to measure the chemistry of the raw sinter mix. The most important oxides are silicon dioxide (SiO_2) and calcium oxide (CaO), and that measurement data is input directly into the control system, enabling automatic regulation of the addition of SiO_2 and CaO based on the PGNAA analysis. This helps HKM respond quickly and appropriately to fluctuations and changes in the input material.

The more uniform sintering process has also yielded cost savings by helping to

increase the volume of sinter going to the blast furnaces.

In addition, HKM has been able to lower the return fines of the sinter and reduce fuel consumption, particularly during the phases when the blending yard is being changed, when it is necessary to respond quickly to changing framework conditions. For example, if the dosage of calcium is insufficient in phases when the mixing area is being changed, this causes the sinter to lose some strength, causing increased pressure loss or reduced performance. The real-time, minute-by-minute analysis that PGNAA technology provides enables rebalancing adjustments to be made quickly, minimising variability.

Additional flexibility

The successor to the analyser that HKM is currently using offers an important additional feature – the ability to use a choice of two different neutron excitation sources: Californium-252 (Cf-252) and a neutron generator. The CB Omni Fusion online elemental analyser provides the option to use either excitation source or allows users to switch between sources at any time. It uses either PGNAA or Pulsed Fast Neutron Activation Analysis, depending on the neutron source selected.

Rapid return on investment

By detecting feed composition variability quickly and reducing the response time, this fully automated technology has enabled HKM to provide better control of additives to stabilise the feed chemistry/basicity. Improved uniformity of the sintering process has enhanced performance and delivered cost savings by increasing the volume of sinter in the furnaces and lowering fuel costs by decreasing return content. Overall, HKM saw a return on investment in less than a year. ■