Real-time Elemental Analysis for Prompt Process Control in Alumina Production

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Abstract

It is necessary to know the real-time chemical composition of raw materials to provide optimal process control and high and consistent quality final product for the efficient mining, beneficiation and processing of bauxite ores. With real-time data, it is possible to manage variations in ore grade, reject unacceptable material, blend different grades of bauxites, make real-time adjustments to the addition of lime, sodium hydroxide and other process raw materials and reagents, and to provide some measure of product quality control. Lyncis offers laser analysers to detect all elements of interest in real-time, directly on site, without sampling, on conveyor belts and in slurry pipelines, eliminating the need for continuous laboratory analysis, often involving hours of delay, and potential human error. These analysers based on LIBS (Laser Induced Breakdown Spectroscopy) do not produce any ionizing radiation, and have operated 24/7/365 in automatic mode under demanding industrial conditions for many years in metals and fertilizer applications. To ensure stable accurate measurements in real time, chemometrics and optimization approaches are used. Traditional calibration methods give unsatisfactory results for real operations, where many other factors such as weather conditions, grain size variation, moisture, etc., influence results. A range of comprehensive spectra filtration and normalization techniques were studied and implemented in our specialized software. It can be easily used by customers and allows fast building of stable and accurate calibration algorithms for every application.

Keywords: LIBS, online analysis, bauxite, alumina, analyser.

1. Introduction

Variations in mineralogy and the presence of impurities such as silica, iron oxides and titania in bauxite (the main raw material used in the alumina industry), not only influence its processing efficiency, but can also increase production costs and create quality deficits in the final product. With real-time data, it is possible to manage variations in ore grade, reject unacceptable material, blend different grades of bauxites, make real-time adjustments to the addition of lime, sodium hydroxide and other process raw materials and reagents, and to provide some improved measure of product quality control.

Growth in the global alumina supply and the tendency to process lower grades of bauxite in future will only intensify the demand for reliable tools for real-time measurements. These measurements can provide the data required to manage impurities, and to make prompt corrections to process parameters without the potential delays of up to several hours for sampling and laboratory based results.

Raw materials in different industries often come for processing with significant variations in chemical and mineralogical composition. These variations are manifest after their extraction from open cast or underground mining, and after they are delivered to and recovered from production stockpiles and raw material transport and transfer systems. Such variations decrease the stability and efficiency of any subsequent beneficiation or processing steps, potentially deteriorate the quality of final products, and decrease production efficiency in general. It is therefore highly profitable to understand any real-time variation in the quality of the feed to processes where settings must assume receiving raw materials with stable pre-set quality parameters.

It is possible to solve the issues caused by quality variation by sorting raw materials by grade, including the rejection of the material unsuitable for specific applications, and by well-informed adjustment of processing parameters based on the real-time measurement of the chemical composition of the raw material. With this information, adjustments can be applied at all production stages, from minerals survey, mining, beneficiation and up to the preparation of feed grades, with more accurate pre-set composition and prompt automatic adjustment of the processing parameters.

In most cases, the information on chemical composition of raw materials on conveyers required for the process control after mining, crushing and blending, for averaging of stockpiles and batching of mixture components, only becomes available to process operators some hours after sampling. For large-tonnage production, such information delays significantly influence the efficiency of the process control. Besides, the precision of the information received is not always high enough, due to the complex procedures required to ensure the representativeness of the samples and their preparation for laboratory analysis.

2. Application of Online Measurement Tools in Alumina Production

Many alumina refineries experience efficiency losses due to the lack of uniform quality bauxite. Bauxite consists of different minerals with silica, iron oxide and titania as the major impurities. The proportion of the minerals varies depending on the bauxite source, and variations in production grades from the same source.

Impurities contained in bauxite are one of the major causes of the inefficiency in the Bayer process. The caustic soda component of Bayer liquor is a critical raw material, being a significant part of total operating costs in an alumina refinery. Its consumption largely depends on the composition of the bauxite processed, and the chemistry of the desilication product produced in the desilication and digestion steps. The concentration of silica in the final alumina product is also strictly controlled due to its negative influence on the aluminium metal product.

With online measurement tools (Figure 1) to provide the chemical composition of materials, production controllers receive the most efficient information for accurate process control in real-time. Such tools make possible timely changes to the Bayer process chemistry, manage impurities in the Bayer circuit (in bauxite ore or in liquor), control caustic soda consumption in desilication, scale formation, and quality of the final product. All this improves cost and energy efficiency, increases refinery output and reduces the variations in alumina quality.

Our experience shows that to get a stable algorithm that can work for a long period, the system user needs to carefully monitor the analyser readings for several months after commissioning and, if necessary, add new calibration samples to the calibration algorithm to take into account the factors described (Figure 11).

6. References

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