Near Infra-Red Based Online Mineral Phase Analysis of Bauxite

Petra Mühlen
Sales Director
SpectraFlow Analytics Ltd, Neuenhof, Switzerland
Corresponding author: petra.muehlen@spectraflow-analytics.com

Abstract

Near Infra-red technology is used by laboratory scale instruments for mineral phase analysis of bauxite ore, to distinguish (for example) between Kaolinite, Gibbsite, Quartz and Boehmite as sources of Alumina and Silica, or to distinguish between reactive and non-reactive Silica. The representivity of laboratory analyses of large-scale flows or inventories of bauxite depends highly on representative sampling, and the availability of these laboratory analyses often involve long delays. Online analyzers are commonly used in mining applications to get an early indication of the actual mined ore quality. Most available technologies can only analyze elemental (often presented as oxide equivalent) concentrations. Near Infra-Red (NIR) based online analysis overcomes that limitation and gives an online mineral phase analysis. Through its mineralogical analysis, the technology can provide accurate analysis of alumina available and the reactive silica along with other mineral composition. It does so without using any radioactive or gamma radiation sources, making the technology safe and without equipment operating limitations. For the user, the direct and online analysis of the bauxite's different mineral phases gives significant advantages, such as using the composition of the mine product for developing and validating block-models for the mine. Specific tests of mine areas by feeding the crusher with the target material and monitoring the analyzer results, allow monitoring of reactive silica content on a stockpile and to react accordingly. It allows to use more variable raw materials for building a stockpile, while still allowing a satisfactory understanding of the instantaneous feed quality and to react with appropriate process control settings in the refinery. This paper and presentation will showcase impressions and results from the first installation in a bauxite mine, where it is presently in operation.

Keywords: Online analysis, reactive silica, mineral phase analysis, near infra-red, bauxite, alumina.

1. Introduction

Shareholder value and reduction of total costs of ownership and production are key drivers in today's world. Despite a recovery in the LME Aluminum price, the demand and supply situation continue to put pressure on most mining companies to work as efficiently as possible. This includes utilization of raw materials from the mine and elsewhere, and of production process additives, their logistics and associated maintenance processes.

Today there is much talk about Industry 4.0, which in practice comes down to increased automation, improved communication and monitoring, along with self-diagnosis and new levels of analysis [1]. These technologies enable faster decision-making in a closed-loop control, resulting in smoother and more efficient processes, requiring less and less human intervention.

Online analyzers are a basic tool for the move towards Industry 4.0, and higher automation levels. Looking at today's mines, trucks and their drivers are being replaced by automated equipment to produce equivalent results. This demands different monitoring further downstream to evaluate if the mined material is useful for further processing, how it shall be utilized, mixed

or even rejected. Conventional 'offline' methods like sampling and laboratory analysis are often too slow for that decision-making process to keep the operation cost efficient.

2. Online Analysis of Bauxite

Bauxite ore is usually mined from multiple areas simultaneously. These areas may have different mineralogy and consequently different available alumina and reactive silica contents. To enable a stable feed to the refinery or bauxite shipment, these raw materials from different sources need to be blended. Usually the only information to ensure a proper blend in real time is the drill hole analysis for the corresponding zone, so an online analysis of the mined bauxite ensures a better blend and avoids exceptional peaks.

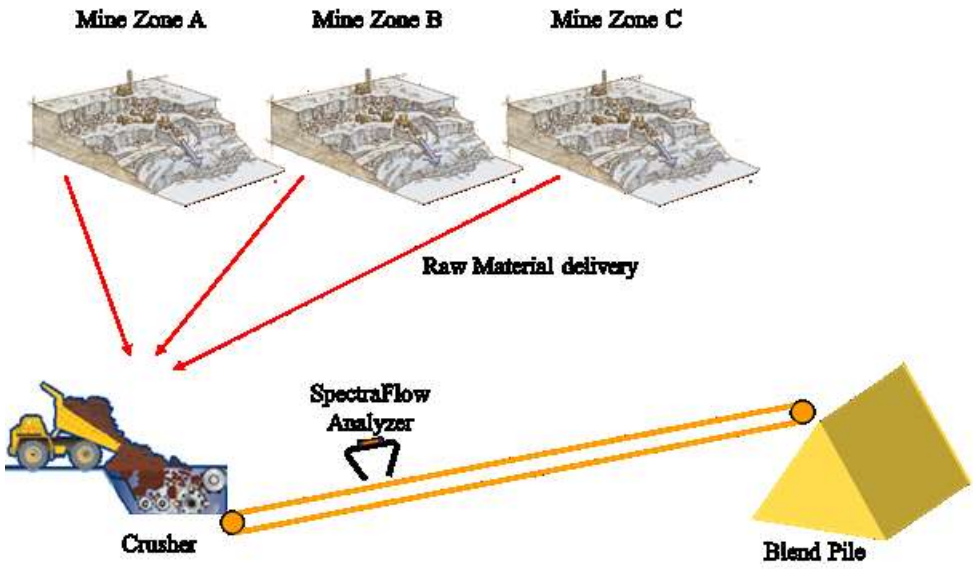

Figure 1. General setup of an online analyzer for pile blending.

The same setup can be the case in a refinery where different bauxite types are processed and where ore types may be blended to create an optimized (quality and cost) refinery feed material.

Online Analyzers are typically characterized by the type of energy source they are using, such as a radioactive source, neutron tube, laser, or a near infra-red (NIR) source presented here. A comparison of the technologies will follow in section 2.5

2.1 Near Infrared Technology for Online Analysis

A still relatively new technology in the market for the online analysis of minerals is based on a near infra-red (NIR) source: a simple halogen light bulb. NIR is electromagnetic radiation with a wavelength range of 700 nm to 2500 nm, possibly emitted by a light bulb or just plain sun light.

The Near Infra-Red (NIR) source gives the technology its name. In NIR applications, light emitted from the halogen bulb shines on the material for analysis. The material absorbs part of the light, more precisely part of the wavelength spectra emitted by the NIR source. Each molecule of the material being analysed absorbs the light at its specific and characteristic wavelength. What is not absorbed is reflected, and this reflection is detected by a lens of an FTIR spectrometer. This spectrometer analyses the absorption (by difference) and returns the corresponding absorbed spectra.

4. Conclusion

The above work shows that the SpectraFlow NIR Online Analyzer can be used for online bauxite analysis for ore blending to reduce variations in the feed to the refinery or to reject certain raw materials and for refinery process control.

The NIR technology, known from laboratory instruments using the same principle, can distinguish between different mineral phases and can analyze organic as well as inorganic material in a direct way without using back-calculations.

The radiation free analyzer with halogen light bulbs as sources and a spectrometer as detector allows operation without permits or specialized radiation officers on site. The design can be light since it requires no shielding and allows installation everywhere without the need for structural reinforcements and makes the analyzer easily movable to alternate between conveyor belts.

The online availability is proven in installations in the cement and iron ore industry, which have similar temperature and dust conditions to bauxite mines and alumina refinery bauxite stockpile areas.

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