Slag Analysis with the Thermo Scientific Niton XL3 GOLDD Series XRF Analyzer

Fast, lab-quality analysis on the production floor

Introduction

Slag is a critical agent in metallurgical processes and serves a variety of important functions. In the production of iron and steel, slag's primary purpose is to purify the iron product through removal of oxides while acting as a protective blanket that stabilizes melt temperatures and helps prevent re-oxidation. Slag chemistry is controlled closely to maximize furnace efficiency, reduce impurities in the product, and prolong the life of the refractory lining of the furnace. After the refining process, slags can be recovered and used for commercial purposes such as ballasts, road fill, or mixed with cement for structural applications.

Application

Slags are composed primarily of silica and lime, with concentrations of other minor constituents, including alumina, magnesia, and other compounds. During the fluxing process, slags remove the non-ferrous constituents from the molten iron, which purifies the product. Magnesium (Mg) is typically found in concentrations ranging from 1% to 10%, aluminum (Al) from 0.5% to 25%, and silicon (Si) from 5% to 40%.

Compositional analysis of slag by energy dispersive x-ray fluorescence (EDXRF) spectrometry is an ideal way to monitor composition during production – to make sure it performs as needed and to evaluate its worth following production. Traditionally, this analysis was done by taking a sample from the furnace (or ladle), then cooling, grinding, and preparing it as a pellet. The pellet was then analyzed using a bench-top EDXRF (or wavelength dispersive – WDXRF) system.

Due to recent technology breakthroughs in instrument detector systems and hardware, handheld XRF systems are simplifying the process of slag analysis. These advanced XRF analyzers can achieve bench-top grade analytical accuracy and precision, in an ultra-portable form factor. This means that analysis can be brought closer to the furnace where users can perform testing at lower costs, save time, and improve melt shop productivity.

Handheld XRF Analyzer

The Thermo Scientific Niton XL3 XRF analyzer with geometrically optimized large area drift detector (GOLDD™) technology is the instrument of choice when users require extreme accuracy, precision, and ease of use. GOLDD technology delivers improvements in light element detection, overall sensitivity, and measurement times – as much as 10 times faster than conventional Si-PIN detectors, and up to 3 times more precise than conventional smaller, silicon drift detectors.

These instruments provide the iron and steel industries with the following key benefits:

- Faster throughput and lower detection limits for higher productivity
- Unparalleled accuracy for confident results every time
- Light element detection (Mg, Al, Si, P, S) without helium or vacuum purge
- Lab-quality performance in a handheld instrument
- Waterproof, dustproof, rugged housing for harsh environments
- Point-and-shoot simplicity with minimal training required

Method

For the purpose of direct comparison with laboratory data, 34 elements were measured on both commercially available and in-house standards using a Niton XL3 900 GOLDD. Helium was used for enhanced performance of Mg through phosphorus (P); however, helium is not required unless it is necessary to measure low levels of Mg with the tightest precision

possible. The analyzer was placed directly on each sample and analyzed for a total of 240 seconds (60 s main filter, 60 s low filter, 120 s light filter). Analysis time and filter requirement depends on analysis goals. For rapid screening, an analysis of 30 seconds or less per filter may be acceptable.

Results

Figures 1 through 4 show the correlation curves for aluminum (Al), calcium (Ca), iron (Fe), and magnesium (Mg) with certified results vs. the Niton XL3 900 GOLDD handheld XRF results. The coefficient of determination (R^2) for each element is provided in the figures. The R^2 value is a measure of how closely the data sets correlate with each other, where a perfect correlation would have an R^2 of 1.

Figure 5 shows the superior resolution and signal-to-noise ration for light elements using the Niton XL3 900 GOLDD analzyer.

Comments

Results achieved using the Thermo Scientific Niton XL3 900 GOLDD handheld XRF analyzer demonstrate excellent agreement with the certified results and prove the instrument ideal for slag composition analysis.

To discuss your particular applications and performance requirements, or to schedule an on-site demonstration, please contact your local Thermo Scientific Niton Analyzer representative or contact us directly by email at niton@thermofisher.com, or visit our website at www.thermo.com/niton.

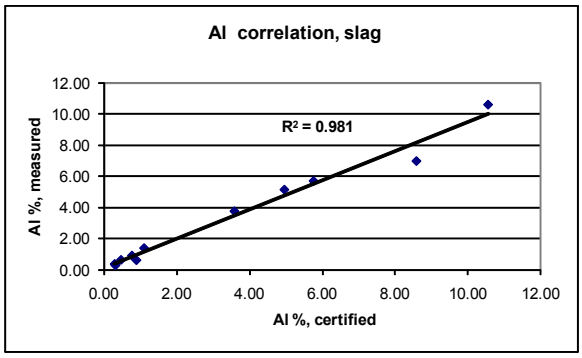

Figure 1. Correlation curve for aluminum – CRM vs. the Niton XL3 900 GOLDD (data is shown in weight percent)

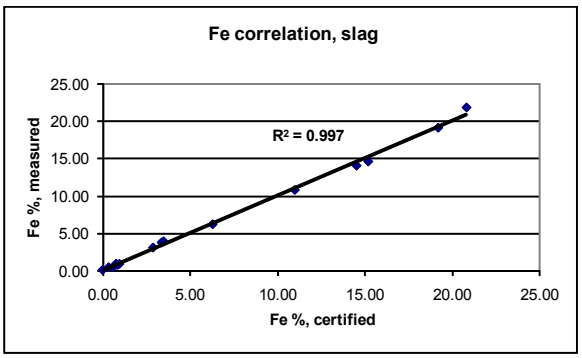

Figure 3. Correlation curve for iron – CRM vs. the Niton XL3 900 GOLDD (data is shown in weight percent)

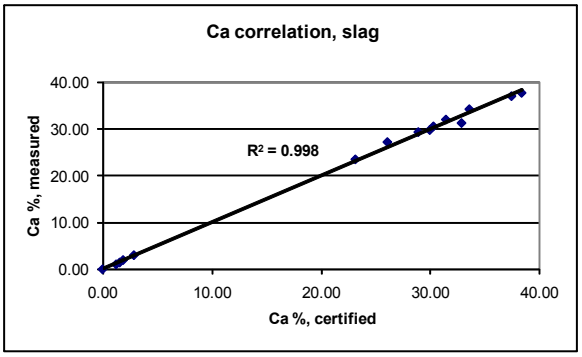

Figure 2. Correlation curve for calcium – CRM vs. the Niton XL3 900 GOLDD (data is shown in weight percent)

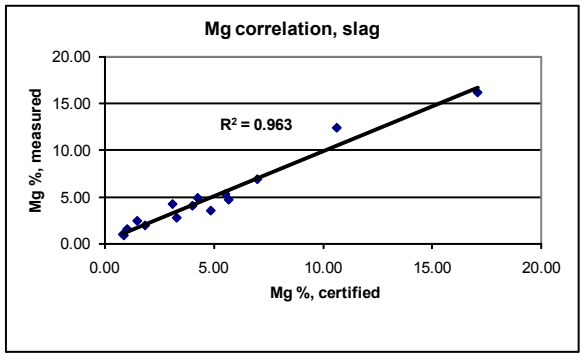

Figure 4. Correlation curve for magnesium – CRM vs. the Niton XL3 900 GOLDD (data is shown in weight percent)

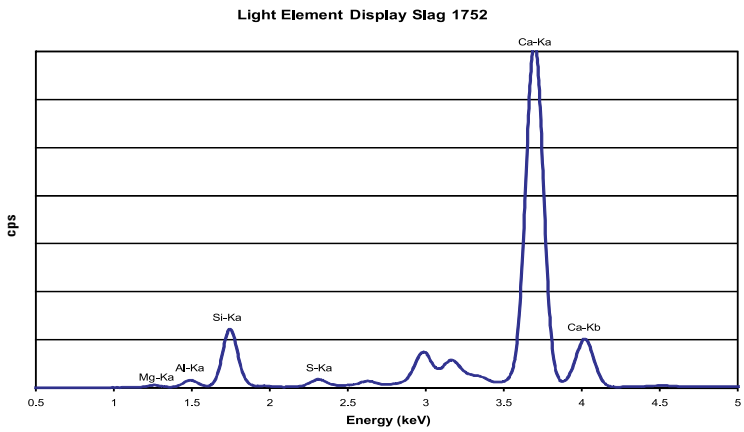

Figure 5. Niton XL3 900 GOLDD light element spectrum

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