Analysis of Silicon Content in Steel and Sulfidic Corrosion with the Thermo Scientific Niton XL3t GOLDD+ Analyzer

Introduction

Sulfidic corrosion of piping and equipment within the refining industry continues to be a significant cause of leaks and issues that can lead to early replacements, unplanned outages, and incidents potentially resulting in loss of property and injury to workers. Carbon steels with low-silicon (<0.10%) content can corrode at an accelerated rate when exposed to H2-free sulfidation corrosion conditions.

According to the American Petroleum Institute (API) Recommended Practice 939-C (Guidelines for Avoiding Sulfidation Corrosion Failures in Oil Refineries), one-third of high-temperature sulfidic corrosion failures are the result of low silicon content. API RP 939-C is a subcomponent of the larger API RP 578 PMI program – the verification of correct alloy installation in all sulfidation surfaces, both proactive and reactive.

Examples of equipment where H2-free sulfidation occurs include crude/vacuum, fluid catalytic cracker, coker, and visbreaker units. Hydroprocessing and hydrocracking units experience H2-free sulfidation corrosion in their feed and distillation sections. To help prevent these incidents from occurring, elemental analysis of such piping and equipment with portable x-ray fluorescence (XRF) is an ideal choice. The Thermo Scientific Niton XL3t GOLDD+ XRF analyzer allows for fast, accurate, and precise elemental analysis in the field.

Thermo Scientific Niton XL3t GOLDD+ XRF Analyzers

The Niton® XL3t GOLDD+ analyzer quickly detects elements from magnesium (Mg) to uranium (U). The instrument makes it straightforward to perform trend analysis by averaging readings in real-time directly on the analyzer or by downloading results later to a PC. It delivers fast, accurate elemental analysis in demanding environments.

The Niton XL3t GOLDD+ analyzer provides the refining industry 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 vacuum or helium (He) purge
- Optional helium purge for enhanced light element performance
- Lab-quality performance in a field-mobile instrument
- Waterproof, dustproof, rugged housing for harsh environments

Method

Fifteen certified reference standards and samples were analyzed directly after ensuring the surface was clean and clear of any contaminants that could introduce silicon or other elements to our analysis. Data quality objectives dictate the sample preparation requirements and the minimum analysis time used for the sufficient data quality required for these measurements. For this application, the samples were analyzed for 60 seconds using both the main filter (10 seconds) and light filter (50 seconds) after thorough preparation.

Results

Figure 1 shows the correlation curves, certified results vs. the Niton XL3t GOLDD+ analyzer results, for Si without the use of helium purge. Figure 2 shows the correlation curves, certified results vs. the Niton XL3t GOLDD+ analyzer results, for Si with the use of He purge. 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 3 shows repeatability data for a single standard 402-2 with a given value for silicon of 0.111% with and without helium.

Conclusion

Results achieved using the Niton XL3t GOLDD+ analyzer demonstrate excellent agreement with the lab results. Given appropriate sample preparation and no introduction of contamination, the analyzer is able to consistently detect Si levels in steel at a level of 0.03% or less. Helium purge allows for improved detection limits in the same amount of time if lower levels of measurement are required. Otherwise, helium purge analysis can be used to achieve the same level of precision as without helium in less time. In this case, the user can reduce total analysis time with helium purge to 25 seconds and achieve the same performance as air path in 60 seconds.

To discuss your particular applications and performance requirements, or to schedule an on-site demonstration and see for yourself how Thermo Scientific portable XRF analyzers can help save you time and money, please contact your local Thermo Scientific portable XRF analyzer representative or contact us directly by email at niton@thermofisher.com, or visit our website at www.thermoscientific.com/niton.

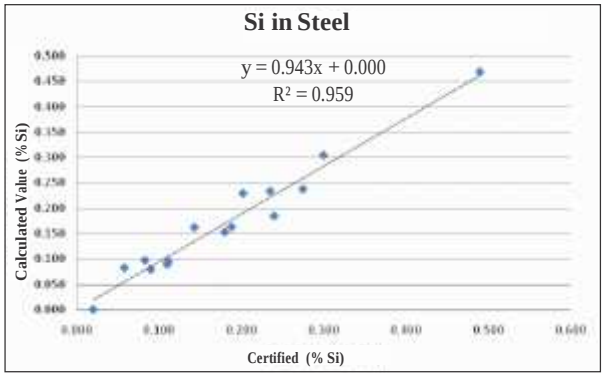

Figure 1: Silicon in steel using the Niton XL3t GOLDD+ analyzer.

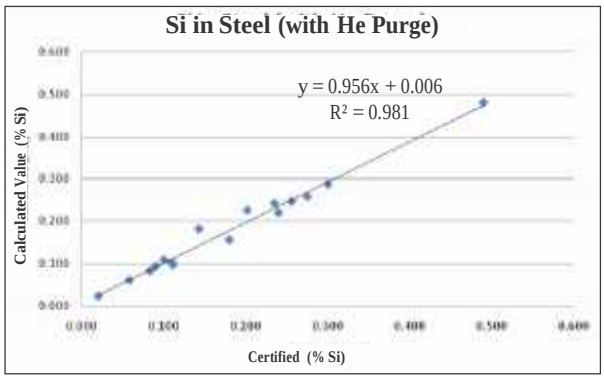

Figure 2: Silicon in steel using the Niton XL3t GOLDD+ analyzer with He purge.

Run#	Niton XL3t GOLDD+ (He Purge)	Niton XL3t GOLDD+ (Air Path)
1	0.102	0.077
2	0.099	0.088
3	0.112	0.097
4	0.103	0.085
5	0.101	0.093
6	0.103	0.107
7	0.111	0.093
8	0.103	0.098
9	0.106	0.088
10	0.095	0.103
Average	**0.104**	**0.093**
Stan Dev.	**0.0055**	**0.0085**

Figure 3: Precision data for silicon in steel

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