

Quality Control of Low Alloy Steel Products

Thermo Scientific Niton XRF Analyzers Enable Rapid Elemental Analysis



Introduction and Overview

The risk of material mix-ups can be a major liability for both manufacturers and users of carbon (C) and low-alloy steels (LAS). Not only is the cost of returns and rework significant, but also the risk of losing customers and the liability of material failures that could potentially cause physical injuries. Because this danger is very real, elemental analysis and positive material/alloy identification have become an increasingly valuable component of many companies' quality assurance/quality control (QA/QC) programs.

Carbon and low alloy steel are classifications of ferrous metals that typically contain less than five percent nickel (Ni) and/or chromium (Cr). Other major elements in this classification are carbon and molybdenum (Mo), with low levels of additional elements added to make minor modifications to the physical properties of the metal.

Forms of carbon and LAS may include rod and bar products (special bar quality – SBQ), oil country tubular goods (OCTG), refinery pipe, forgings, wire, plate, sheet, and coiled steel. Included among the companies that could benefit from elemental analysis of low alloy steels are primary metals producers, foundries and forges, distributors and service centers, fabricators, and facilities with installed LAS components in critical process areas that may be prone to failures.

The importance of verifying the elemental makeup of metal alloys has increased over the years as more suspect materials are imported from overseas, and the recycled component of steels rise causing an increase in undesired tramp elements. Carbon content is very important, but requires complex instruments to measure, as well as significant sample preparation and additional testing time. Therefore, many companies limit themselves to testing for variations in manganese (Mn), Ni, Cr, and Mo.

Elemental Analysis Techniques

QA/QC inspectors and manufacturing engineers have access to a variety of powerful elemental testing techniques – including nondestructive x-ray fluorescence (XRF).

Optical Emission Spectroscopy (OES)

OES instruments have been the overwhelming choice for carbon and low alloy steel testing for more than 35 years. This technique vaporizes a small amount of the material and analyzes the emitted light spectrum to determine the elements present and their relative concentration. Material that has been tested using this technology exhibits small burn marks on the surface where the test took place. There are two main modes for OES testing, “arc” mode and “spark” mode.

Arc mode

The advantages of “arc” OES systems are that the test is relatively fast (3-5 seconds) and is more forgiving of adverse surface conditions. However, these instruments cannot detect light elements such as C, phosphorus

Thermo Scientific Niton XRF GOLDD Analyzers Benefits At-a-Glance

- Instant results – material verification in seconds
- Simple and easy to use – little training necessary
- Confident results every time; P and S detection with GOLDD technology
- Accurate testing of small diameter products
- Nondestructive – the analyzed materials are not damaged in any way
- Fast, simple reporting and certificate generation



The Niton XL3t GOLDD+ PMI.

(P), and sulfur (S), and elemental accuracy can range as high as +/- 20 percent relative. Further, the electrode and the pistol head must be cleaned regularly to ensure accurate analysis and to prevent cross-contamination between materials. Burns from these tests create surface blemishes of a few millimeters in diameter and also can have considerable depth (approximately 1 mm).

Spark mode

With the introduction of the argon-shielded “spark” test, analysis of C, P, and S became possible. Accuracy improved over the “arc” mode, but careful surface preparation and a skilled operator are needed to achieve good results. These systems are bulky, with transportable versions available that have a testing “gun” tethered to a rack-based operating system. Burns from spark tests can create significant surface blemishes up to 10 mm in diameter, but are not as deep as the arc burns (~0.1 mm).

Handheld X-ray Fluorescence (HHXRF)

Handheld x-ray fluorescence provides a completely nondestructive method for elemental analysis and positive alloy identification. This technology makes use of the ability to ionize elements by sending low-power x-rays into the sample and then reading the returning fluorescent x-ray signal to determine the elements present along with their relative concentrations. Historically, HHXRF has not been used in the analysis of many carbon and low alloy steels due to the high sensitivity required for accurate testing of chromium, nickel, and molybdenum at concentration levels below 0.10 percent. Now with the improved LODs in the new Niton XL2 GOLDD and Niton XL3t GOLDD+ XRF analyzers, this sensitivity is achievable.

Although surface preparation is still important due to the fact that carbon and low alloy steels tend to oxidize quickly and may have scale buildup, it is generally

much less intensive for HHXRF than it is for portable OES systems.

Figure 1 shows the accuracy of the Niton XL3t GOLDD+ analyzer on nickel, chromium, and molybdenum. Fifteen certified reference materials (CRMs) were analyzed after light surface preparation. They were analyzed for a total of 25 seconds (10 s on the main filter, 15 s on the light filter) with an average of three tests on each of the fifteen samples. The resulting figure indicates the correlation curve for Ni, Cr, and Mo with the certified values vs. the Niton XL3t GOLDD+ handheld XRF results.

The coefficient of determination (R^2) for each element is provided. 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.

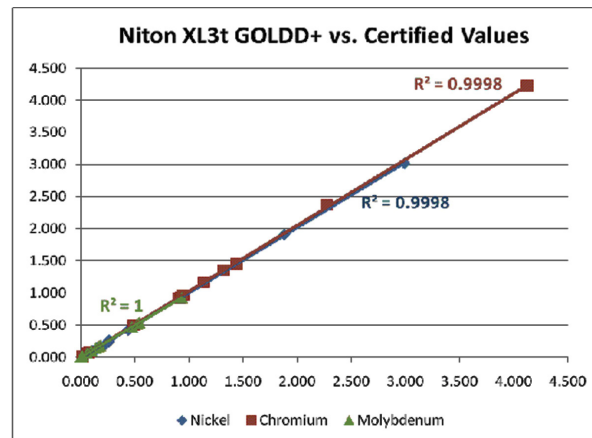


Figure 1. Correlation curve for Ni, Cr, and Mo – CRM vs. the Niton XL3t GOLDD+

Thermo Scientific Niton XRF Analyzers – Value and Performance

Whether you choose the performance-leading Niton XL2 GOLDD or the Niton XL3t GOLDD+, the ultimate choice in features plus performance, you will benefit from fast, accurate elemental analysis and grade identification to aid in manufacturing quality assurance and quality control. Discover how these industry-leading analyzers can help you with your low alloy steel analysis needs. For additional information, contact your local sales representative or visit us at www.thermoscientific.com/niton for assistance in determining which model is right for you.

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