Nondestructive Analysis of Welds and Welding Materials

Verifying the Critical Chemistry of Alloy Weldments with Handheld XRF

Overview

The use of proper filler material is a major factor in the successful joining of alloys to ensure the quality and integrity of a welded joint. When choosing the optimum filler alloy, both the base materials and the desired qualities and performance of the weldment must be carefully considered.

Once the metallurgical engineer has specified the filler material for a given application, many users simply depend upon their supplier to provide the correct alloy as marked. Unfortunately, mistakes and mix-ups in this material can and do happen. In some industries, a mix-up in the weld material will simply degrade the quality of the final product. In others, such as petrochemical piping systems or aerospace applications, the consequences of using the wrong filler material can range from costly to disastrous, and may involve loss of property, loss of revenue, and even loss of life.

Positive material identification (PMI) using handheld x-ray fluorescence (XRF) has become essential for verifying weld materials and final joints at various stages of the use cycle, including incoming material inspection, in-process verification, and final product inspection.

The Requirement for PMI

In high-risk services, 100% material inspection is usually required – with many industrial customers such as the petroleum and chemical processing industries requiring PMI documentation from their fabricators and suppliers. Handheld Thermo Scientific NITON® XL3 Series XRF analyzers are the world standard in PMI instrumentation. Welding materials, piping, components and associated parts all can be easily verified prior to assembly and installation, as well as tested during in-service operation using these high-performance analyzers.

This procedure provides operational savings by reducing the time required for maintenance or turnaround, and has the potential for saving months of operational losses under potentially catastrophic conditions.

WeldSpot, an optional, revolutionary small-spot feature allows users to better isolate and analyze welds; use in conjunction with CamShot CCD camera and sample imaging system.

NITON XL3 Benefits At-a-Glance

- High throughput – fast, comprehensive testing
- Laboratory quality composition analysis
- Optional WeldSpot small-spot focus feature for better isolation of weld beads and CamShot CCD camera, sampling imaging system for positioning, analyzing, and recording analytical results
- Easy verification of weld materials prior to assembly and installation
- Non-destructive – the analyzed materials are not defaced in any way
- Little or no sample preparation required

Superior Alloy Testing

Our standard handheld analyzer will simultaneously quantify a suite of 22 elements including Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Zr, Se, Cb (Nb), Mo, Pd, Ag, Sn, Hf, Ta, W, Re, Bi, and Pb; and will positively identify the grade of the material based on the calculated composition.

These versatile analyzers can be used for screening a very wide range of alloy materials from low alloy steels, Cr-Mo steels, and stainless steels to complex nickel-based alloys such as Hastelloys™ and Inconels™ to more exotic materials such as titanium, tantalum, or tungsten.

Typical testing times run from as little as 1 second with high alloyed materials to 30 to 60 seconds for quantification of trace elements in carbon steel and light elements in the abovementioned alloy groups. XRF analysis is completely nondestructive to the component being tested, with little or no sample preparation required. Our analyzers come equipped with a pre-programmed alloy library of several hundred of the most common alloy grades. However, these grades can be modified easily or supplemented by the end user.

Ensuring Weld Integrity with XRF

The overall integrity of the welded joint depends on a number of factors, including proper preparation and verification of the correct base material, setting of proper parameters for the technique being used, and use of the proper filler alloy. Our XL3 Series analyzers are ideal for both verification of the base material(s), as well as verification of the filler metal prior to welding. The instrument can be used to test single welding rods, spools of weld wire material, or a solidified sample of puddled material to verify the filler material prior to the welding operation. The results of these tests are stored within the XL3 XRF analyzer, and can be downloaded easily to a Windows®-based PC or Pocket PC for reporting and PMI documentation supplied to the customer or client.

This dilution rate can be accurately verified by chemical analysis of the deposited bead using our analyzer (see Table 1). In this case, the deposited bead must be isolated so that the base materials are shielded from the instrument's "field of view."

We have two ways to reduce the size of the measurement window: a clip-on weld adapter attached to the front end of the analyzer or our optional Thermo Scientific WeldSpot™ 3 mm small-spot focus feature*, which allows users to toggle between full area analysis and small sample areas. This on-board, one-touch, icon-selectable feature is always immediately available for use and is never lost. The capability is there when you are ready to use it. Nothing to lose. Nothing to leave behind.

WeldSpot, combined with Thermo Scientific CamShot™ view*, the first CCD camera and sample imaging system to be integrated into a handheld XRF analyzer, is ideal for positioning, analyzing, and recording the analytical results of small weld areas and components – something previously only achievable with benchtop XRF analyzers. The XL3t displays a picture of the tested area on the instrument screen and stores the image along with the analysis data for easy reference, data management and data integrity.

Conclusions

The need for positive material identification in today's quality-minded and risk-based environment has never been greater. Decades of development work have gone into making handheld Thermo Scientific NITON XRF analyzers the smallest, fastest, and most reliable analysis tools ever built. Their ability to rapidly analyze and identify alloy materials has provided the inspection and quality functions with a dependable and cost-effective means of ensuring the safety and integrity of alloy joining systems – even down to a 3 mm focus area with our WeldSpot and CamShot features. Today, with the economic losses and potentially catastrophic consequences of mixed or incorrect materials, the reasons are more compelling than ever for testing every alloy material and weld both before use and during routine inspection of installed systems.

*Available only on XL3t models

Contribution of filler material:	Contribution of Member A	Contribution of Member B
.70 x .70 = 49% Ni	.15 x .67 = 10% Ni	.15 x .08 = 1.2% Ni
.70 x .15 = 10.5% Cr	.15 x .32 = 4.8% Cu	.15 x .18 = 2.7% Cr
.70 x .08 = 5.6% Fe		.15 x .74 = 11.1% Fe

The final weld bead chemistry should be:
60.2% Ni (49% + 10% + 1.2%); 13.2% Cr (10.5% + 2.7%); 16.7% Fe (5.6% + 11.1%); and 4.8% Cu.

Table 1: Filler material dilution rate

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