Quality Assurance of Critical Fasteners

Thermo Scientific Portable XRF Analysers Enable Rapid Elemental Analysis

Introduction

Fasteners are such a universal component of so many machines and assemblies used on a daily basis that we tend to take them for granted, until something goes wrong. Fasteners, particularly those used in mission-critical situations, must be designed, fabricated, inspected, and installed properly or lives can be put at risk. For this reason, it is imperative to ensure that fasteners for these critical applications are made from the precise metal alloy called for in the design specifications. This verification can be accomplished quickly, easily, and accurately using a handheld x-ray fluorescence (XRF) analyser.

The Challenge

From time to time, the subject of improper or counterfeit fasteners is one that appears in the mainstream press. For example, in March 2000, Boeing discovered that it had 330,000 fasteners that were made from the wrong alloy.[1] The Company had to slow down production to remove and replace these fasteners on planes going through assembly and also had to recall 20 planes that had already been put into service. The manufacturer of the fasteners said it had received incorrect alloy material from its metal supplier. The material test report (MTR) indicated it was the correct alloy grade, but, in fact, it was not. Had the fastener supplier performed incoming XRF inspection on its incoming metal stock, it could have caught this problem before manufacturing and delivering all of these parts, saving not only the costs incurred in correcting the situation, but perhaps more importantly, avoiding the loss of confidence of one of its largest customers.

Another problem is that of counterfeit parts. Even NASA has felt this impact. Before the scheduled launch of the Astro-1 space lab, NASA discovered that the bolts in the space lab were defective.[2] Astro-1 had to be dismantled so the bolts could be replaced with the right ones. This took six months and cost NASA $1 million. The dishonest supplier turned out to be a one-person company operating out of a garage. A handheld, easy-to-use analyser could have saved a lot of time and money in such a case. In fairness to NASA and others, this type of analyser was not readily available back in the early 1990s. However, portable XRF technology has made huge advances in the years since, so much so that today's analysers are capable of even distinguishing alloy grades that are nearly identical in composition to one another.

Benefits of X-Ray Fluorescence

XRF is a non-destructive testing technique that can analyse a metal sample in seconds with little to no need for sample preparation. All of our analysers are calibrated using NIST traceable standards. Further, they are handheld, portable, and require no vacuum system. This makes XRF the ideal solution for performing incoming inspection on metal alloys from suppliers as well as for doing final quality assurance and control before shipping finished parts.

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Application Note

Handheld XRF analysers have benefitted greatly in recent years from advances in detector technology. State-of-the-art analysers now use a Silicon Drift Detector (SDD) instead of the traditional Si-PIN detector. To take full advantage of the capabilities of these new detectors requires other changes to the analyser as well. For example, to generate more useful x-ray events, the miniature x-ray tube is dynamic, meaning the voltage is automatically changed from 5 to 50 kV to selectively excite specific ranges of elements for improved detection limits. Also, to gather more of the fluorescent x-rays, the detector has been moved closer to the sample and the detector itself has a larger diameter. The net result has been an order of magnitude improvement in the capability of the analyser, particularly for lighter elements such as magnesium, aluminium, silicon, phosphorus, and sulphur.

Handheld XRF analysers are used in a wide variety of applications from lead paint inspection to mining exploration to Positive Material Identification (PMI). Examples of PMI applications include identifying the exact alloy grades used in piping, valves, and flanges that transport hazardous chemicals in refineries or chemical plants. In the fasteners market, XRF is used for inspection of incoming raw material to ensure it matches the alloy grade and composition documented on the material test report. It is also used for final quality inspection before finished parts are sent to the customer. This "double-check" process helps ensure that the incoming raw materials and the outgoing finished parts meet the expected engineering requirements.

Using the latest SDD technology – which combines improved light element detection with improvements to the software and the alloy library on certain handheld analysers – has enabled users to quickly and automatically tell the difference between alloys that have very similar compositions. For instance, the difference

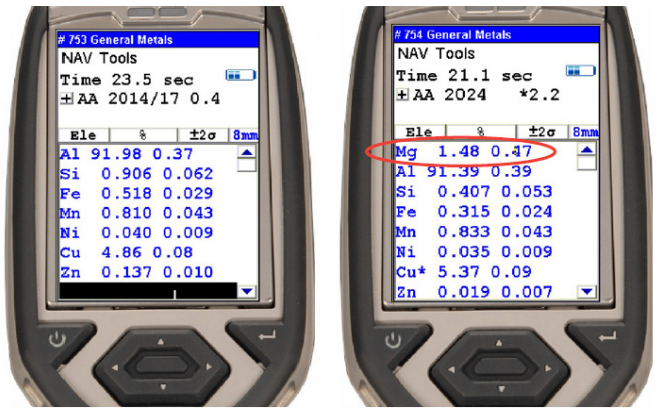
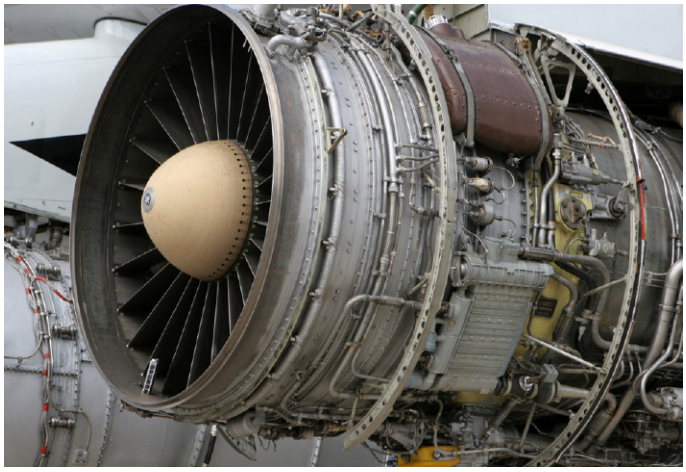


Fig. 1. Screen shots comparing 2014 with 2024



berween 2014 and 2024 aluminium is primarily the magnesium content. 2014 has a minimum of .2% magnesium to a maximum of .8%. 2024 has a minimum of 1.2% magnesium up to 1.8% as shown in figure 1. Magnesium is a light element and not easy to detect. In fact, before the introduction of the most advanced SDD technology, it was impossible to detect in an atmospheric environment. By taking advantage of this technology and optimized excitation of the sample, it is now possible to tell the difference between parts made from these two very similar alloys in real time, with no helium or vacuum purging needed.

Summary

Advances in handheld XRF technology have greatly expanded the capabilities of today's analysers. Whereas the main XRF market for many years was metals recycling and the fairly easy task of separating 304 and 316 stainless steel, these new capabilities make the analysers indispensable tools for performing PMI of incoming raw materials, work in progress, and final quality assurance of finished parts. Many fastener applications, such as those for aerospace, power generation, or the military, are truly life and death situations. With all this in mind, Positive Material Identification should be required as part of any final quality assurance program such as ISO 9001.

To discuss your particular applications and performance requirements, or to schedule an on-site demonstration, please contact your Niton UK on 01256 397860 or email us at info@nitonuk.co.uk, or visit our website at www.nitonuk.co.uk.

References
[1] Associated Press: "20 Boeings Found Faulty," Seattle Post and Courier, March 8, 2000.
[2] G. Crouch: "Safety Threat Seen; Counterfeits Now Nuts, Bolts Issue," Los Angeles Times, Jan. 27, 1989.

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