Application note

Thermo Fisher SCIENTIFIC

Quality control and assurance for lead-free brass

Niton handheld XRF analyzers enable rapid screening

Introduction

Even at low levels, exposure to lead is harmful to humans, especially to children. When exposure accumulates over time, serious damage can occur to the kidneys or nervous system, and cardiovascular conditions or cancer may develop. One of the main sources of lead exposure occurs through the consumption of drinking water. Historically, lead was utilized in drinking water service lines as well as in water pipes, pipe fittings, plumbing fittings, and plumbing fixtures. Over the past fifty years, multiple laws and regulations have been issued at federal or state levels to address this key public health issue.

The Safe Drinking Water Act (SDWA) in the United States was originally passed in 1974. It was amended in 1986 with a goal of greatly reducing the amount of lead that would leach into drinking water. One of the biggest culprits of leaching was solder, which until that time could contain up to 50% lead. The amendment reduced the amount of lead allowed in solder to less than 0.2%. At the same time, the allowable amount of lead in brass was reduced to no more than 8%.

In January 2011, Public Law 111-380 was signed, which further amended the SDWA and, once again, significantly reduced the amount of lead allowed in any new plumbing components that come into contact with drinking water in the US. With the new allowable level of lead in these brass components lowered to 0.25% by weight, the government set a date of January 2014 for the new lead-free brass law to take affect; this gave manufacturers, distributors, and installers time to prepare for the change.

Regulation in this area has continued to expand. Beginning in September 2023, manufacturers and importers have been required to obtain product certifications. Such certifications can come from an accredited third party, or a company can self-certify its products if the company fulfills the criterion of eligibility in the US Code of Regulations 40 CFR 143.19.[1]

In addition, the US Environmental Protection Agency (EPA) proposes to strengthen its Lead and Copper Rule (established in 1991 to control lead and copper in drinking water) and to finalize a US-wide inventory of lead water service lines by October 16, 2024, with the aim of having those lines replaced in the following ten years.

Testing and Analysis

The National Sanitation Foundation (NSF) International has been at the forefront of the lead-free plumbing products initiative for decades and has been working closely with the US Environmental Protection Agency (EPA) and many individual US states to ensure that drinking water is safe. NSF International joined with the American National Standards Institute (ANSI) to create the NSF/ANSI/CAN 372-2022 standard[2] for measuring the lead content of drinking water system components. This standard can be used by accredited third party certification bodies, as well as manufacturers or importers of plumbing products who are eligible for self-certification.

The following analytical technologies can be used, according to section 7.1 of NSF/ANSI/CAN 372-2022 standard for screening of components used in plumbing products: optical emission spectrometry (OES), scanning electron microscopy (SEM) with energy dispersive X-ray (EDXRF) spectrometry and X-ray fluorescence (XRF) spectrometry. An important requirement for those technologies to be used for screening is that the calibration process must be performed using certified reference materials.

The screening must include all parts with wetted surface areas in excess of 10% of the total wetted surface area of the product. Those parts include but are not limited to metals and alloys parts made of stainless steel, galvanized steel, or brass; they also include certain plastics and elastomers. An average value of the lead content of all wetted parts weighted with the relative wetted surface area is calculated to determine if that average value exceeds the regulated threshold value of 0.25 weight % of lead.

Handheld X-ray fluorescence

Among the technologies accepted for screening of plumbing products is handheld XRF. Analyzers such as the Thermo Scientific™ Niton XL2 XRF Analyzer (Figure 1) can be used to analyze brass samples or other components in seconds with no or little sample preparation. The results—both the identification of the alloy grade according to copper association standards as well as the chemical composition—are displayed in real time on the analyzer screen. Also, with a threshold value set at 0.25%, a pass/fail message is displayed to inform the user if results are below or above the regulated level (Figure 2). The instruments are pre-calibrated in the factory and are ready to operate upon arrival. The calibration is stable over years and traceable to NIST or other certified reference materials. As shown in Figure 3, the results of analysis for lead show high accuracy over several orders of magnitude.

Conclusion

Regulation of lead in plumbing for drinking water has been steadily increasing in the US, and handheld XRF analyzers are well-suited for helping manufacturers, distributors, and importers meet regulatory requirements. Handheld XRF analyzers are easy to deploy in point-and-shoot mode for performing non-destructive analyses in the warehouse or near the assembly line. With little or no sample preparation, this technology enables third-party certification bodies to increase testing throughput and productivity. Also, handheld XRF is very cost effective, and it makes an ideal tool for manufacturer and importers to use for the self-certification process. XRF is the method of choice for performing incoming inspection on metal alloys from suppliers and for doing final quality assurance and control before shipping and installation of finished parts. It is also well suited for tracking and maintaining separate inventories of leaded and non-leaded brass parts.

References

1. US Code of Federal Regulations §143.19
2. NSF/ANSI/CAN 372-2022 standard, Drinking Water System Components – Lead Content

Figure 1. Point and shoot analysis of a valve body.

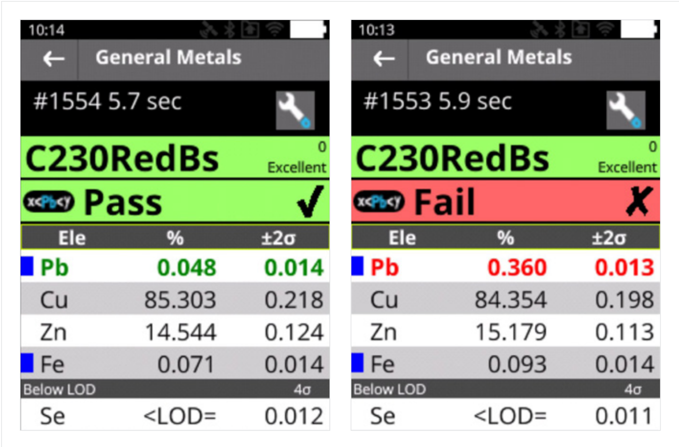

Figure 2. Results of analysis of a valve body below and above the threshold value of 0.25 wt%.

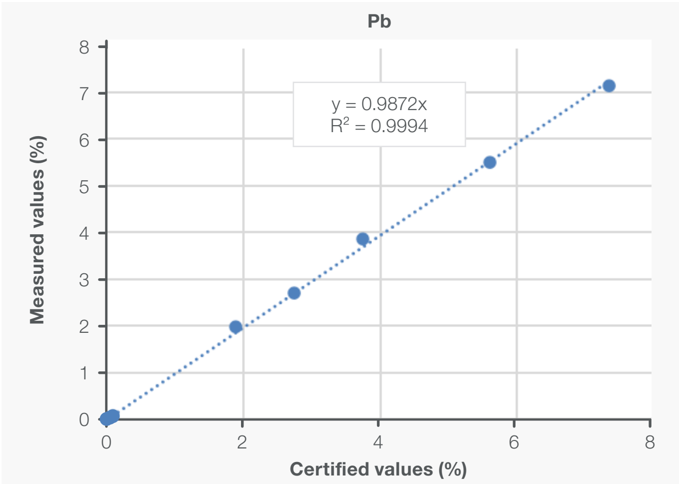

Figure 3. Certified vs. measured values for lead in copper-base reference materials.

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