# Not just for analyzing metals anymore

*XRF analyzer suitable for evaluating oils, troubleshooting machinery*

**By Eric Lundin, Editor**

If you need to sort through a small pile of metal scrap to separate steel items from aluminum, or if you need to figure out if a stray tube is carbon steel or stainless steel, a magnet is the way to go. However, if you need to identify an alloy and quantify its chemical composition (elemental content), you need something more sophisticated. This is where X-ray fluorescence (XRF) can be helpful.

The XRF process bombards the object under test with X-rays, imparting energy to a sample of atoms in the object. When that energy is released just milliseconds later, it gives off a series of distinctive signatures. The XRF detector evaluates these signatures and, in doing so, determines the specific elements and the relative quantities of each in the alloy.

This branch of science is XRF spectroscopy, which studies the interactions between matter and electromagnetic radiation, but you don't need a science degree or a fancy title ("spectroscopist") to use this technology. To analyze the spectrum given off by the object under test, you just pull the trigger and the tool does the rest.

Let's say you have an alloy consisting of 80 percent copper, 11.5 percent lead, 6.5 percent tin, and 1 percent each of zinc and nickel. That's a tin bronze, which goes by the Copper Development Association (CDA) designation 936 copper. An iron-based alloy that has 0.15 percent carbon, 0.60 percent manganese, 0.040 percent phosphorus, and 0.050 percent sulfur is a low-carbon steel, designated 1018 by the American Iron and Steel Institute (AISI). A similar alloy that has a little less carbon, 0.10 percent, and another element, silicon, at 0.10 percent, is an old friend, 1010 carbon steel.

XRF analyzers have been available for decades, so they're nothing new, but according to Mark Lessard, a market development manager for Thermo Fisher Scientific, industry needs them now more than ever.

## Review, Repair, or Replace

It's commonly known that manufacturers rely on XRF to identify incoming material and scrap dealers use the technology to segregate material, but these are just two of many applications.

"We see significant growth potential for mission-critical applications," Lessard said, referring to catastrophic events. "In the petrochemical industry, using the wrong alloy can result in an explosion. The implications are much more severe if materials get mixed up in a nuclear power plant or at an aerospace component manufacturing facility," he said.

Sometimes the hazard isn't as abrupt, but it can be devastating nonetheless.

"Much of the pressure is regulatory in doing repairs or in reviewing a construction project," he said. "Using the wrong material can lead to corrosion, and corrosion can lead to failure."

Of course, some applications aren't mission-critical, but mixups can have huge cost implications.

"For about 100 years, the automotive industry relied on steel," Lessard said. "These days the industry is using aluminum, magnesium, and titanium." Verifying that the right alloy showed up at the receiving dock is an ideal use for an XRF detector, as is keeping the incoming raw materials and the scrap from production segregated every time they're handled. The pressure is on to improve fuel efficiency, and one of the tactics is to use the lightest-weight metals possible. As the material's weight drops, the cost increases. Nobody wants to make thousands of parts from the wrong alloy.

An XRF analyzer also can be used to check a coating thickness, including passivation or conversion coatings, which is an important step when preparing a steel surface for a bonding agent, Lessard said.

"Auto manufacturers have been using adhesives for years and their use is only going to grow," he said. "When using an adhesive, it's critical that the coating thickness is correct to ensure the structural integrity of the bond," he said.

## The Pace of Technology

Technologies are ever-changing—compare a digital camera or a computer or a cell phone of today with one from a decade ago—and this includes XRF analyzers. According to Lessard, the company's latest unit, the Thermo Scientific Niton XL5, is much more capable than its predecessors.

"The unit has about three times better the level of detection than previous units," he said, stating that the latest unit can detect the presence of some elements down to single-digit parts per million. As recently as five years ago, this level of detection (LOD) was available only with laboratory-grade analyzers, not hand-held units, Lessard said. This has the potential to benefit any industry that relies on recycled metals.

*Photo courtesy of Thermo Fisher Scientific, Tewksbury, Mass.*

"It's often a matter of what is not supposed to be in the metal as what is supposed to be in it," he said. The risk of contaminating known metals with tramp metals—so-named because they are as unwelcome as tramps, vagrants, and other ne'er-do-wells who tend to show up uninvited—is more prevalent than ever due to growing recycling efforts. A low LOD is necessary for any scrap dealer that guarantees the furnace melt chemistry content of the scrap, as the top-tier recyclers do.

Lessard attributed the falling LOD in today's analyzers to the same forces that have been improving other electronic items, steady progress in both software and hardware. Just as other equipment types have shrunk while their capabilities have increased, so too have XRF analyzers.

"The new model is a departure in size compared to previous models," he said. This is handy in a refinery or a chemical processing plant in which the staff needs to analyze every pipe, valve, and flange.

"A smaller analyzer is a big benefit because the user can get it into tighter, hard-to-reach

areas," Lessard said. "It's much easier and less expensive if they can use it while the processes are running. Otherwise they have to shut down a system or a subsystem and partially dismantle it to remove the components that were in the way."

At the same time, the XL5 doesn't just benefit from a compact size. It actually has some of the same technologies you'd find in a digital camera or a mobile phone. Wireless technologies such as Bluetooth® and Wi-Fi provide connectivity to a computer back at the office and to other XRF analyzers. Thermo Scientific's latest unit is also equipped with two imaging capabilities, micro and macro.

"The microview assists in pinpointing a specific analysis location," Lessard said. "For example, the microview could show that the unit analyzed a weld bead but not the surrounding material. The macroview is helpful in that it provides an image of the entire unit or assembly." Both of these images can be attached to the Certificate of Analysis.

At the same time, the unit itself can be tailored to provide specific functions, depending on who's using it.

"Each user can create a unique profile," Lessard said. "User A might have a particular set of conditions that differ from those of User B or User C." Lessard cited the work done in a quality control department, which would focus on specific details, as differing from the broad, big-picture analysis needed at the managerial level as an example.

## Detecting Elements in Oil

Spectroscopy is a versatile technology, one that has other uses anywhere lubricants are used to keep machinery humming. If lubricants could talk, they'd spill a lot of beans about the state of the machinery they lubricate. They can't talk, but spectroscopy gets answers anyway.

On one hand, the simplest application is just a matter of analyzing the metal content of a lubricant when the lubricant is new and then analyzing it on a regular schedule after that. A gradual increase in the concentration of metal fines is normal; a sudden increase is a sure sign of trouble, possibly indicating a component is on the verge of failure.

On the other hand, spectroscopy can provide specific information about a machine, providing diagnostic information. A jump in one specific alloy could indicate an impending component failure. If you know what the machine's components are made from—if it has titanium valve spring retainers or copper Babbitt bearings, for example—a sudden change in the content of either of these alloys indicates trouble and points to its origin. Accurate predictive failure analysis is invaluable, especially in industries that measure downtime in thousands of dollars per hour.

Finally, when the oil is finished, spectroscopy isn't. An XRF analysis of a container of the discarded sludge lets the waste company know the content of it so it can determine how to dispose of it in keeping with legal guidelines. FAB

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