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Featured Article

ADVANCEMENTS IN POSITIVE MATERIAL IDENTIFICATION TOOLS BRING ACCURACY AND CONVENIENCE TO THE WORK SITE

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INTRODUCTION

There is no substitute for safety, and the path toward putting safety protocols and mechanisms in place varies by industry and company. Whatever the type of business, new innovations in technology can help companies implement safety initiatives in a more cost-effective and efficient manner.

In numerous industries that require elemental and material testing, including the oil and gas, power generation, and petrochemical industries, positive material identification (PMI) is at the forefront of any operation. In fact, an increasing number of facilities are adopting a 100% PMI program to ensure that every metal component is made up of exactly the desired chemical composition. To do so, more and more plants are adopting portable x-ray fluorescence (XRF) technology, which brings increased reliability and accuracy to material analysis in a manner that can reduce the risk of accidents while offering significant cost and time savings.

RAPID TECHNOLOGICAL DEVELOPMENTS

Over the last decade, analysis techniques that had previously only been feasible in a laboratory setting have become available to more quality control personnel in the field. Technology, in the form of handheld instrumentation, is now smaller and faster which has had a beneficial impact on refineries, power plants, chemical plants, and other types of facilities by making sure the right materials will be used and have been installed in the right places.

XRF spectroscopy, which bombards a sample with high energy x-rays, analyzes the composition of a sample by measuring the spectrum of fluorescent x-rays emitted by the different elements. While XRF spectroscopy has been used for about 60 years, the technology has recently become portable through the use of a miniaturized tube to emit x-rays.

When a user simply points and shoots, a primary x-ray beam is sent into the sample via the x-ray tube, releasing energy in the form of fluoresced x-rays. These x-rays are measured by a silicon drift detector (SDD), which can identify and quantify the element or elements. Today, a handheld XRF spectrometer can instantaneously determine not only the concentration of each element in a sample, but also identify the alloy name, thanks to an on-board alloy library.

Figure 1. Many refineries have assumed 100% PMI program adoption to ensure that every metal component is made up of exactly the right composition to reduce risk of accidents, maximize safety, and ensure 24/7 productivity. Photo courtesy Thermo Fisher Scientific.

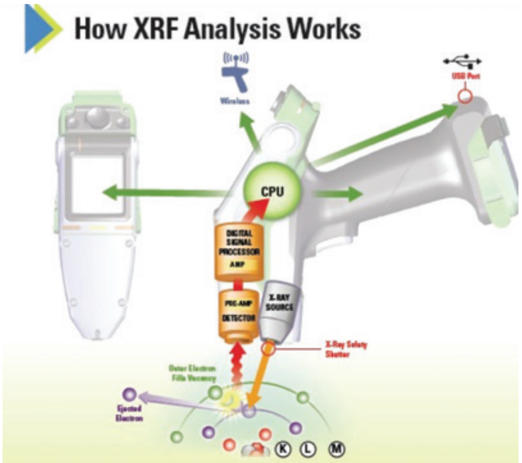

Figure 2. Diagram demonstrating how XRF analysis works. Image courtesy Thermo Fisher Scientific.

Figure 4. New technology allows users to analyze tight spots easily and without a stoppage in overall facility production. Photo courtesy Thermo Fisher Scientific.

← Microalloy

#354 32.0 sec

LA-C Steel — 0 Excellent

Ele	%	±2σ
Nb+V+Ti	0.066	0.006
Nb+V	0.056	0.005
Nb	0.012	0.003
V	0.044	0.002
Ti	0.010	0.001
Ni	<LOD=	0.204
Cr	0.065	0.002

Figure 3. Onboard alloy identification. Image courtesy Thermo Fisher Scientific.

The most revolutionary forms of XRF technology have the ability to analyze lighter elements on the periodic table, such as magnesium and aluminum, and can analyze any element faster and at lower levels of detection than ever before. This gives the operators the ability to analyze a sample for residual or "tramp" elements that can get into an alloy when scrap metal is melted down, and to confirm the presence of desired elements for micro-alloys. Furthermore, the improvements in size, speed, and performance (the smarts are essentially built into the instrument) bring significant benefits to the user.

Take the petroleum refining and petrochemical sector as an example of where XRF analysis has had a strong impact on PMI processes. The current industry standard for quality assurance/quality control (QA/QC) is to verify the makeup of 100% of materials. This emphasis on PMI is driven by safety, as corrosion, faulty components and other concerns can lead to, and have led to, catastrophic incidents.

Refineries operate around the clock, and thus QA/QC personnel require the ability to inspect piping, welds, and every other piece of metal without shutting down the facility. The smaller the analytical instrument, the easier it is to access hard-to-reach areas while the refinery is up and running. Previous generations of XRF analyzers would require a shut-down in order to conduct the testing—a major hindrance to efficiency.

Likewise, the speed of analysis in today's instruments means that QA/QC operators have become extremely efficient and productive. Users can get results from testing a sample within just a few seconds, allowing them to make immediate decisions based on the analyzer's findings. Furthermore, because today's analyzers do the work in a point-and-shoot manner, the user does not need to be an expert in spectroscopy to operate them. The time savings come in the form of both quick analysis and minimal need for extensive training.

Acuren, a North American company that provides inspection services and solutions to refineries, power generation firms and many other industries, has adopted XRF technology as a tool of choice in serving its clients. In Houston—where Acuren has a regional office—PMI Manager Mark Lang has used XRF for a dozen years and has most recently adopted the new Thermo Scientific Niton XL5 analyzer, which was introduced to the market in September 2015 and which he says "offers accuracy as well as repeatability." A critical benefit of the analyzer is that it can shoot and gain results in very small sample areas, meaning Acuren's inspectors can increase productivity by analyzing more samples and more areas within a sample in a shorter period of time.

"The industry has really picked up on using the XRF analyzers to make sure the alloys that they have in their systems are correct," said Lang, who conducts retro PMI testing in major Houston-area refineries as well as fabrication shops before components are installed. Acuren's fleet of instrumentation across North America includes more than 100 XRF analyzers.

Achieving 100% PMI is the standard. Inspection companies like Acuren, which serves major companies like Exxon, Chevron, and Shell, are compelled to take advantage of the latest breakthroughs in XRF technology.

ANALYSIS OF MICROALLOYED STEELS

One specific area of elemental analysis in the oil and gas industry has greatly benefitted from handheld XRF spectroscopy: microalloyed steels. They can be found in oil and gas line pipes, heaters, reactors and many additional industrial applications, and they are estimated to comprise about 12% of the world's total steel production. Microalloyed steels take low-carbon mild steel and add "micro" alloy concentrations. To reach their intended properties, niobium, vanadium, and titanium are added to strengtheners such as boron, molybdenum, nickel, chromium, and copper.

Figure 5. New handheld technology offers speed, accuracy, and productivity to PMI inspectors. Photo courtesy Thermo Fisher Scientific.

Why are microalloyed steels so advantageous? They provide lower fabrication costs over hot-rolled carbon steel from weight savings, and their reduced carbon content improves weldability and weldment toughness. In general, they bring increased pumping capacity to in-line pipe, which leads to operational savings.

Installation of microalloyed steels typically requires 100% PMI. The only way this is feasible is by using instrumentation that can identify micro elements quickly and reliably. Furthermore, the instrumentation must provide the capability to find and measure elements at extraordinarily low levels of detection to identify trace levels of niobium, vanadium, titanium and, critically, residual elements as well.

As the technology for manufacturing microalloyed steels in the oil and gas sector has dramatically improved in recent years, chemical compositions have become more complex. They can consist of variable combinations of several chemical elements depending on factors like intended use, alloy costs, and pipe wall thickness. It all adds up to a challenging process for material identification—a process that necessitates high sensitivity and accuracy.

ENHANCING WELD ANALYSIS

Along the lines of microalloyed steel analysis, the ability to positively identify elements in weld metal is a significant advantage made possible by today's handheld XRF analyzers. Two factors are at play here: the sensitivity of the on-board camera and the capability to automatically reduce the analysis beam spot size from 8 mm diameter to 3mm diameter. Both characteristics are important to ensure compliance with precise weld material specifications.

As handheld instruments continue to decrease in size, users are able to bring them into more and more locations in the field. In oil refineries and petrochemical plants, access to welds can be a major obstacle, especially if the objective is to maintain operational efficiency by avoiding a shutdown to analyze a certain area. To have a sleek handheld analyzer that is small enough to access awkward corner welds or tight spots and collect 100% of the necessary data goes a long way for the user – including a reduction in user fatigue. Meanwhile, continued improvement in camera performance provides pinpoint accuracy in shooting the x-ray at

Figure 6. Operators inspecting pipeline weld integrity at a refinery. Photo courtesy Thermo Fisher Scientific.

a specific analysis location. The more precisely the instrument can focus on one spot, the more confident the user can be with the data being generated.

And all of these advantages tie back to safety, because user confidence in PMI data corresponds to confidence in the integrity of the part being analyzed. Depending upon the risks, anything short of 100% PMI can lead to catastrophic events in a plant or along a pipeline.

INNOVATION DRIVES SAFETY AND PRODUCTIVITY

Taking lab-quality analytical instruments and bringing them closer to the job site is an evolving objective for scientists and product developers. For many industrial applications, size and speed improvements have reduced the need for laboratory testing and have increased the ability for personnel in the field to maximize the use of newly developed technology.

XRF spectroscopy is squarely in this category. New technology allows users to get answers within seconds, make decisions on their findings, and avoid costly and time-consuming trips to the lab. Instead of waiting days to verify the alloy composition in a material, QA/QC operators at the work site will know on the spot whether a weld is sound or they need to temporarily shut down their equipment. It can be a life-saving moment, and the instrument is smart enough to make the call.

As innovation accelerates, productivity does as well. In industries that require complete positive material identification, commitment to the latest available technology goes a long way toward saving costs, saving time, and saving live. ■

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