TÜV SÜD | Vol. 4 November 2011

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Editorial

Dear Readers,

Welcome to the Fall 2011 issue of PetroChem E-ssentials, the quarterly e-newsletter of PetroChem Inspection Services, a subsidiary of TÜV SÜD America.

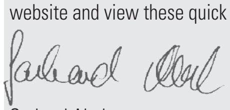
Nondestructive testing (NDT) has broad application in the many industries served by PetroChem, and offers many advantages over other testing and inspection techniques. But choosing an appropriate NDT method for the inspection of plants and materials requires matching the characteristics of the inspection environment with the capabilities of the chosen inspection method. In our lead article, "Nondestructive Testing: A Techniques Primer," we review the uses and benefits of several of the leading NDT inspection methods.

Within the broad range of NDT techniques, conventional radiographic testing (RT) is a reliable and time-honored approach that enjoys a loyal following among inspectors. However, a number of new techniques based on ultrasonic technology offer significant advantages over traditional RT inspection methods, and can save inspectors both time and money. Our article "Ultrasonic vs. Radiographic Testing" compares RT with ultrasonic testing methods from the perspective of safety, quality of results, and speed.

The routine inspection of ferromagnetic and non-ferromagnetic tubes used in boilers and heat exchangers is a cost-effective method of identifying necessary repairs before unplanned plant shutdowns occur. The article "Techniques in Tubular Verification" reviews the various tubular inspection techniques that are available, and discusses the importance using trained inspection personnel in your tubular inspection program.

The increased use of hazardous materials and other volatile material mixes can cause chemical reactions that can lead to serious injuries or even death. Although material test reports are widely used to keep track of potentially dangerous materials, a formal material verification program is essential to ensure product quality and prevent tragic accidents. In the article, "The Importance of a Material Verification Program," we discuss the technologies used in material verification, and the key elements of an effective material verification program.

We round out this issue with additional information about our newly released on-demand videos highlighting our advanced inspection services (available at our website at www.petrochemintl.com/videos). We invite you to visit our website and view these quick demonstrations.



Gerhard Abel
President, PetroChem Inspection Services

Nondestructive Testing: A Techniques Primer

In the petroleum and hydrocarbon refining and processing industries, nondestructive testing (NDT) is an essential tool that can be used to evaluate materials and systems while maintaining and preserving costly plant and infrastructure investments. However, there are a number of NDT techniques from which to choose, each utilizing unique technologies that are appropriate for specific applications. This article provides an overview of various NDT techniques and their uses.

REAL-TIME RADIOGRAPHY (RTR)

RTR uses low-dose x-rays to produce images. However, unlike conventional radiographic testing, RTR captures images electronically rather than on film. This approach all but eliminates the lag-time between initial exposure and the resulting image.

RTR testing units are usually lightweight portable devices that include a highly sensitive x-ray imager and a battery-operated x-ray tube, making them ideal for portable field operation. These devices are also typically equipped with electronic recording capabilities that allow for the capture of still images or video.

To view a video demonstration of PetroChem's Real-Time Radiography capabilities, visit http://petrochemintl.com/aboutus/videoplayer.cfm?video=RTR_FINAL_w_Today

RTR is most commonly used for rapid inspection of pipes, and is capable of scanning anywhere from 100 to as much as 500 feet of pipe per day, depending on the application. This speed allows the inspector to quickly and economically identify areas of concern that can be further examined with more expensive testing methods. RTR is a particularly useful technique in corrosion under insulation (CUI) surveys, and can identify areas of wet and saturated insulation.

RTR is also useful for inspecting welding locations in insulated pipe, and can easily locate welds in support of positive material identification (PMI) programs. However, the use of RTR is limited to pipes and insulation that do not exceed 27 inches at the tangent.

GUIDED WAVE (GW) ULTRASONIC INSPECTION

GW ultrasonic inspection involves the use of a testing unit that generates ultrasonic energy. The energy is directed down the length of a pipe and returns to the transducer ring in the testing unit in a pulse-echo fashion. Any change in the cross section along the length of the pipe generates reflected energy (i.e., ultrasonic signals) that can be analyzed and used to identify areas of wall loss within a pipe.

GW ultrasonic inspection provides 100% coverage throughout the pipe's test length, even when only limited access is available. Therefore, it is commonly used for in-service inspection of otherwise inaccessible piping, such as elevated piping or piping used at road crossings.

However, as a screening tool for piping, GW testing provides qualitative but not quantitative results. Defective areas that are identified using GW testing require the use of complementary testing methods or visual inspection to acquire specific data. Further, a number of variables affect the range and sensitivity of GW testing. For example, travelling through bends distorts the GW signal, making feature or defect classification unreliable.

To view a video demonstration of PetroChem's Guided Wave Ultrasonic Inspection capabilities, visit http://petrochemintl.com/aboutus/videoplayer.cfm?video=GuidedWave_FINAL_T.

ELECTRO-MAGNETIC ACOUSTIC TRANSDUCERS (EMATS)

Unlike conventional UT transducers, EMATs create ultrasonic energy by inducing an alternating current within a magnetic field. EMAT testing units have two probes, a pulser and a receiver. The pulser sends an ultrasonic signal in both directions around a pipe's circumference, and the receiver receives the signals from both directions. Changes in the UT signal represent changes in the piping material, such as wall loss.

An EMAT inspection can be conducted on any piping that is physically accessible, including dock lines, sleeper racks, and elevated piping. It can detect small, isolated defects down to 1/8 inch in diameter, as well as generalized wall loss from corrosion or erosion. EMAT also allows for the rapid screening of long pipe lengths, and can inspect as much as 1,000 feet of piping in a single shift while providing qualitative results and identifying defect locations for follow-up inspection.

To view a video demonstration of PetroChem's Guided Wave Ultrasonic Inspection capabilities, visit http://petrochemintl.com/aboutus/videoplayer.cfm?video=EMAT_FINAL_T.

PHASE ARRAY (PA) ULTRASONIC INSPECTION

PA ultrasonic technology electronically modifies the acoustic probe characteristics of conventional transducers. PA testing units use multiple elements in a single housing, excited at specific intervals, to generate uniform wave fronts at specific angles. Electronic images are then created from the received ultrasonic energy, allowing for the identification of defects and their location.

PA ultrasonic inspection offers high-speed electronic scanning without moving parts, and can inspect multiple angles using a single, electronically controlled probe. Data can be collected in either manual or encoded modes. Most ultrasonic techniques for flaw detection can be applied using PA probes.

To view a video demonstration of PetroChem's Phased Array capabilities, visit http://petrochemintl.com/aboutus/videoplayer.cfm?video=Phased_Array_FINAL_T.

However, environmental temperature can impose limitations on the use of PA ultrasonic inspection, due to the sensitivity of the small electronic components and transducer elements used. Other limitations on the use of PA ultrasonic technology include the size of the transducer footprint, and low amplitude responses from energy diffusing or scattering reflectors, such as material porosity.

TIME OF FLIGHT DIFFRACTION (TOFD) ULTRASONIC INSPECTION

ToFD is a multi-mode ultrasonic inspection technique that measures the flight time of the sound energy through the material under inspection, from one probe to another. ToFD ultrasonic inspection is typically used to inspect welds and base material for flaws, cracks, root erosion, corrosion, and cladding conditions. It can completely cover a typical butt weld, the heat-affected zone (HAZ) and the base material adjacent to the weld from a single position.

ToFD ultrasonic inspection can be performed in less time than a manual ultrasonic inspection, and can more accurately evaluate the through-wall dimension of defects. ToFD inspection devices can also produce an image that can be archived for repeat inspection, as a tool for ongoing monitoring of an identified defect. Perhaps most important, a ToFD inspection does not interrupt production compared to other radiographic inspection techniques.

AUTOMATED ULTRASONIC TESTING (AUT)

AUT is the automated robotic deployment of conventional or advanced ultrasonics to produce consistently articulated and encoded data. AUT applications include weld and cladding inspection, corrosion mapping, and inspection for hydrogen-induced cracking (HIC) and stress-oriented HIC (SOHIC).

AUT-based inspections offer consistently incremented and repeatable scanning, and increased speed and accuracy of inspection. These advantages enhance post-collection data analysis, including fitness for service calculations. AUT is also capable of calibration verification.

The limitations of AUT inspection largely reflect the way in which AUT equipment operates. For example, AUT systems typically use magnetic wheels to secure them to equipment under test, so surfaces must be clear of loose debris. In cases where non-ferromagnetic materials are being evaluated, tracks of some sort must be attached to the material to hold the AUT in place. Finally, AUT systems typically require power to operate the electronics and motor controllers, although smaller AUT systems may be operated with battery power.

To view a video demonstration of PetroChem's Automated Ultrasonic Testing capabilities, visit http://petrochemintl.com/aboutus/videoplayer.cfm?video=AUT_FINAL_T.

ALTERNATING CURRENT FIELD MEASUREMENT (ACFM)

ACFM was originally developed for use on offshore structures in the North Sea, and has been used in the United States to inspect pressure vessels for environmentally induced cracking. ACFM-based inspection equipment is capable of detecting and sizing cracks in most metals, and can be used as a replacement for conventional magnetic particle and liquid penetrant testing.

ACFM can be used to inspect a wide range of materials, including carbon steel, stainless steel, aluminum, and nickel-chromium-based super alloys. ACFM inspections do not require extensive cleaning of inspected surfaces or the removal of coatings. ACFM-based inspections are also 60-70% faster than conventional inspection, often allowing rapid, single-pass inspection.

To view a video demonstration of PetroChem's Alternating Current Field Measurement capabilities, visit http://petrochemintl.com/aboutus/videoplayer.cfm?video=ACFM_FINAL_T.

CONCLUSION

Each material and system inspection situation typically presents a complex set of unique circumstances and challenges. The proper selection of an appropriate NDT inspection technique must be made in that context, and involves the careful evaluation of the specific attributes and benefits of each technique. An experienced consultant can provide valuable perspective and advice when it comes to identifying the right inspection technology for each situation. ■

Ultrasonic vs. Radiographic Testing

Non-destructive Testing (NDT) using conventional x-ray methods have been used for inspection purposes for many decades. But Radiograph Testing (RT) has not changed much, at least in terms of the technological advances they offer. And, having used RT for many years, inspectors originally trained on the method are reluctant to evaluate other inspection technologies.

By comparison, Ultrasonic Testing (UT) has made a number of important technological advances since it was first introduced as an inspection method. Today, a number of UT-based inspection methods are now routinely used in the field. Techniques such as advanced sizing methods, time of flight diffraction (ToFD), and phased array (PA) ultrasonic testing offer significant capabilities that enable them to outperform RT-based inspections on many different levels.

To view a video demonstration of PetroChem's Ultrasonic Testing capabilities, visit http://petrochemintl.com/aboutus/videoplayer.cfm?video=AUT_FINAL_T.

This article offers a brief comparison between conventional RT methods with those methods available using UT technologies.

SAFETY CONCERNS

Safety is first and foremost on everyone's mind. Accordingly, technicians must be licensed in their respective state to conduct RT inspections, and must carry RT safety cards and dosimeters to ensure that they are not overexposed to potentially harmful radiation. Areas subject to RT inspection must be cordoned off in order to protect nearby individuals from unnecessary radiation exposure, and components being tested with RT are typically removed from the premise where they can be safety-tested. Taking these precautions can be challenging in small facilities, or during turnaround or shut-down periods, when personnel are performing a variety of tasks.

UT examinations, on the other hand, use no radiation and no harmful chemicals. Technicians, employees, and nearby equipment are not in danger of harmful exposure. Inspections can be performed in close proximity to welding or fabricating personnel and processes. And UT equipment is small, portable, and usually handled by one technician, making easy access to components feasible.

QUALITY ISSUES

RT inspections produce visible images of the insides of components, and are mostly used to inspect welds. RT has the ability to find almost all of the weld-related defects that can form during weld manufacture or through in-service use. However, it is difficult to identify crack and crack-like defects using RT, unless the camera is positioned at the proper angle when images are taken.

In contrast, UT testing offers most of the same benefits of RT inspection without the risk. Almost all weld-related defects that form during weld manufacture or through in-service use can be found using UT inspection. Cracks, planar flaws, and slag/porosity or volumetric defects are readily detected. Unlike RT, UT also allows for through-wall sizing and depth of defects to be presented. Knowledge of the precise location, length and depth of flaws allows manufacturers and repair crews to quickly pinpoint the location of the flaw, and repair the area with minimal disturbance.

TIME REQUIRED

A further complication with the use of RT derives from the inability to determine the quality of the image until the film is actually processed. Several things can go wrong when capturing an RT image, for example, not enough or too much exposure time, poor quality film, the position of the camera, or poor quality film chemicals. If the image captured is inadequate for any reason, the RT inspection process must be repeated. Since inspection times using RT already require cordoning off the area to be tested, setting up the camera, capturing the image, and then breaking down the equipment, repeating the inspection process because of poor quality images will waste valuable time and interfere with normal operations longer than necessary.

UT equipment provides almost instant results. The technician knows immediately if changes need to be made to the equipment's calibration or if a different technique is needed to enhance the inspection images. UT equipment is also user-friendly, easily allowing the necessary changes to be made to produce better images. Many advanced techniques like ToFD and PA even allow for digital images of the UT signals to be produced and analyzed on the spot.

SUMMARY

In general, UT is a safer, more reliable and more efficient inspection method than that available with conventional RT technologies. Costs are comparable between the two methods, and thick components, such as heavy walled reactors and vessels, can be inspected much more easily and safely using UT methods. Although there are some applications where RT represents a better choice, nearly every RT inspection can be done using UT methods.

PetroChem Inspection Services offers a range of NDT services using UT technologies, including ToFD testing, PA testing, guided wave testing, and automated testing. For additional information about PetroChem's UT inspection capabilities, visit www.petrochemintl.com/NDTservices. ■

Techniques in Tubular Verification

The routine inspection of ferromagnetic and non-ferromagnetic tubes in air coolers, chillers, boilers, condensers, evaporators, and other heat exchangers is a cost-effective method of identifying the need for repairs in advance of unplanned plant shutdowns. There are a variety of tubular inspection techniques, including eddy current, remote and near-field testing, and internal rotary inspection system (IRIS) inspection, each with their own advantages and drawbacks. This article reviews the various tubular inspection techniques that are available.

EDDY CURRENT INSPECTION

Eddy current is an electromagnetic technique that induces electrical currents (i.e. eddy currents) in electrically conductive/non-ferromagnetic materials. The electrical currents are affected by any change in the geometry or permeability of the material being inspected that interferes with current flow. The resulting signal identifies such changes.

Eddy current can be used to inspect non-ferromagnetic materials, including stainless steel, copper, nickel, brass, and titanium. It is capable of distinguishing between various types of flaws, including general or localized corrosion, cracking or pitting, or baffle cuts. Depending on the tube length, the eddy current technique can inspect between 500 and 7000 tubes during each eight-hour shift.

To view a video demonstration of PetroChem's Eddy Current Inspection capabilities, visit http://petrochemintl.com/aboutus/videoplayer.cfm?video=Tubular_Inspection_FINAL_T.

REMOTE FIELD TESTING

Remote field testing is an electromagnetic technique for inspecting ferromagnetic tubes that utilizes low frequencies to penetrate the material being evaluated. Remote field is a send/receive through-wall transmission technique that does not utilize magnetization to saturate tube material. The send and receive (exciter and pickup) coils are separated by two to three tube diameters.

Remote field testing can be used to evaluate carbon steel, 400 series stainless steel, and duplex stainless steel, and can inspect heavy wall thickness, up to 180 inches. The technique is equally sensitive to all types of material flaws and discontinuities, including general or localized corrosion, pitting greater than one-eight inch in diameter, and baffle cuts. Depending on the tube length, the remote field technique can inspect between 250 and 500 tubes during each eight-hour shift.

NEAR-FIELD TESTING

Near field testing does not depend on through-wall transmission. Instead, sensor coils are placed close together and testing relies on the condition of the tube close to the coils, as the signal barely penetrates outside the tube wall. Near field testing also takes advantage of lower frequencies than remote field testing to penetrate the material under test. The technique uses probes that accommodate both remote field and near field coils, or near field coils alone.

Near field testing can be used to inspect ferromagnetic materials, including carbon steel, 400-series stainless steel, and duplex stainless steel. It can distinguish between inside and outside defects, and is particularly useful for measuring defects close to, and even under, support plates and tube sheets. Near field testing is ideal for inspecting possible defects in fan tubes.

IRIS INSPECTION

An internal rotary inspection system (IRIS) emits an ultrasonic immersion pulse echo from a transducer, which travels parallel to the tube axis until it hits a rotating 45 degree mirror, which directs these pulses onto the tube wall. As the mirror rotates, the ultrasonic beam traverses the tube circumference, and each successive pulse is mapped out as a B-scan line on the screen.

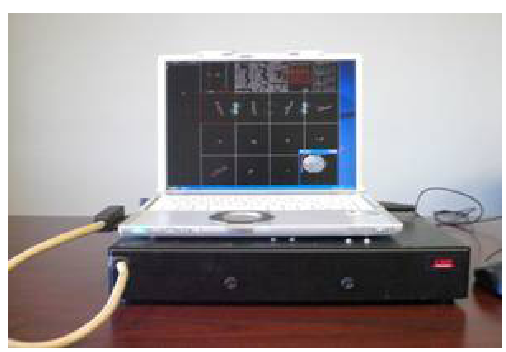
The IRIS technique is useful for inspecting both ferromagnetic and non-ferromagnetic materials, and is suitable for detecting and sizing discontinuities such as general or localized corrosion, pitting, cracking, and baffle cuts. Depending on the tube length, IRIS inspection can process about 200 tubes during each eight-hour shift. However, some materials with a tube wall thicknesses of less than 0.035 inches cannot be reliably measured.

To view a video demonstration of PetroChem's IRIS nspection capabilities, visit http://petrochemintl.com/aboutus/videoplayer.cfm?video=Tubular_Inspection_FINAL_T.

OTHER CONSIDERATIONS

The training of inspection personnel plays a major role in the success of any tubular inspection process. At a minimum, inspection technicians should be thoroughly trained to operate and effectively utilize all of the features of the test equipment selected. Extensive knowledge and experience in analyzing signals produced by test equipment is also important, since decisions regarding maintenance and repairs often depend on accurate signal interpretation. Certification in accordance with the requirements of the American Society of Nondestructive Testing (ASNT-TC-1A) can provide assurances that selected technicians are sufficiently qualified to address the most challenging inspection situations.

PetroChem Inspection Services personnel have extensive experience in selecting and using the appropriate tubular inspection technique for each unique situation, including eddy current inspection, remote and near-field testing, and IRIS inspection. For additional information about PetroChem's tubular inspection services, visit www.petrochemintl.com/tubularinspection. ■



The Importance of a Material Verification Program

In process industries that use hazardous materials, materials with exacting specification, or materials which are exposed to either low or high pressures, the unintentional mixing of specified materials can cause chemical reactions that can lead to serious injury or even death. Material test reports (MTRs) have been the tradition method to identify and track such materials, but historic data of existing critical component systems is often lacking or otherwise unavailable. And, it can become even more difficult to determine if and when incompatible materials have been mixed during the fabrication, installation or reassembly of components during routine maintenance operations.

Efforts to oversee and audit material verification programs have been stepped up as a result of increased reports of accidents and injuries attributed to the use of improper materials. In response, industry groups such as the American Petroleum Institute (API) have issued recommended practices (API RP-578) for material verification to help plant owners and operators maintain the mechanical integrity of their systems and prevent catastrophic release of highly hazardous materials. In general, a material verification program that follows recognized and established good engineering practices is an important part of an overall quality assurance program that can prevent accidents and minimize the risk of shutdowns for plant owners and operators.

The most commonly used method for qualitative and quantitative material verification is portable spectrographic units utilizing various technologies. These units literally bring the metallurgical laboratory into the field to verify that the correct materials have been installed. This verification can include individual base components as well as their joining materials, such as welding, bolting, and gaskets.

One such technology is x-ray fluoroscopy (XRF), which uses a radiation source to excite the material under test, producing a fluorescent spectrograph of the elements of the material. The spectrograph is then compared to those of other commonly used material grades stored in the testing unit's library. XRF is an extremely accurate test method for verifying some low-alloy steels, most high-alloy steels, and other select metal alloys. However, XRF is limited by its inability to quantify light elements such as carbon, silicon, sulfur, and phosphorous.

Another verification technology, optical emission spectroscopy (OES), employs a spark or arc to excite the material under test, thereby obtaining a full spectrum of light wavelengths. This method provides a quantitative percentage of all metals and metal alloys, and can also be used to verify light element content, such as carbon in low alloy steels and high alloy stainless steels, that (XRF) cannot quantify.

Unfortunately, the actual use of such technologies often fails to provide accurate diagnostic information. Plant owners and operators may purchase material verification test equipment for use by employees who have little or no experience or training in its proper operation. In other cases, the test equipment is used without the benefit of a written procedure. Finally, there is often no formal material verification program, or one that has not been updated to the latest standards, or which excludes items that outside auditing professionals will monitor.

The best material verification program should meet or exceed the mechanical integrity standards of each individual industry. However, at a minimum, the program should consist of the following elements:

- A material verification procedure that conforms with the requirements of the current version of API RP-578, or other applicable standards
- The latest XRF and OES equipment
- Written test procedures for using both XRF and OES equipment
- Training for XRF and OED operators, including formal qualification and certification
- An outside review of the material verification procedure

An experienced third party can provide valuable expertise and guidance in establishing and maintaining a quality material verification program that conforms with industry requirements, and which minimizes safety risk to plant personnel. For additional information about material verification programs, visit PetroChem Inspection Services at www.petrochemintl.com/PMI. ■

New Videos Available from PetroChem Inspection Services

PetroChem Inspection Services, a subsidiary of TÜV SÜD America Inc., is pleased to announce the release of its new suite of on-demand product videos, highlighting the company's advanced inspection services.

Featuring PetroChem technical experts, the videos present quick overviews on the range of PetroChem's specialized service offerings. Here's a list of the video topics currently available for viewing:

- PetroChem Company Overview
- Alternating Current Field Measurement (ACFM)
- Automated Ultrasonic Testing (AUT)
- Electromagnetic Acoustic Testing (EMAT)
- Guided Wave Ultrasonics
- Phased Array
- Rope Access
- Real Time Radiography (RTR)
- Tubular Inspection

The on-demand videos are available at the PetroChem website at www.petrochemintl.com/videos, or at PetroChem's *new* You Tube channel, www.youtube.com/user/TUVPetroChem.

PetroChem Inspection Services provides consulting and testing services to meet the needs of the energy industry, including petrochemical production and refining, nuclear power, and wind power. For additional information about PetroChem, visit www.petrochemintl.com. ■

Congratulations to the iPod Touch Raffle Winner!

PetroChem Inspection Services is pleased to announce that Mr. Greg Wakefield from MATCOR, Inc. was the winner of our iPod Touch Raffle held to promote the launch of the company's social media profile pages. Mr. Wakefield's name was picked at random from followers on PetroChem's social media sites.

In an effort to continue to keep customers current on technical topics, events, training, and more, PetroChem launched profile pages on social media websites in August, 2011. The company can now be found on Twitter at http://twitter.com/#!/TUVPetroChem, on LinkedIn at http://www.linkedin.com/company/t-v-s-d-america/petrochem-370144/product, and on Youtube at http://www.youtube.com/user/TUVPetroChem. ■

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