

Custom Ultrasonic Immersion Tanks

Using an immersion tank with integrated ultrasonic multi-axis scanner has proven to be an effective method of evaluation for irregular, oversized and mixed-media components and materials, providing precise, automated inspection and data capture capabilities

Ultrasonic testing is a well-established method for conducting non-destructive testing of everything from forged metal parts to advanced composites and alloys. Ultrasonic scanning can help assess material characteristics such as thickness and homogeneity, or detect flaws such as cracks, porosity and delamination. Ultrasound inspection systems typically use one or more ultrasonic transducers that are moved over the surface of the item being tested. To be effective, a liquid substance (called a “couplant”) such as oil, gel or water is needed to transmit the sound waves most efficiently from the transducer into the item being tested.

However, some items are more challenging to test because they are very large, have irregular or complex shapes, or are composed of multiple materials. Manufacturing firms, research organizations and test laboratories sometimes need to conduct non-destructive evaluation of cast, forged, welded and composite components and alloys of all shapes and sizes that can be difficult to test using standard methods. Often, slow and labor-intensive manual testing has been the only option.



2,400 liter ultrasonic immersion tank

The Immersion Tank Approach

For these testing challenges, using an immersion tank can be a solution. With a tank scanning system, the item to be tested is immersed in water, which acts as the couplant in continuous contact with every surface of the item. Combined with multi-axis scanner assemblies that allow imaging from multiple angles, and mechanical elements that can rotate or move an item in the water, ultrasonic immersion testing can provide thorough and accurate test results to detect flaws and assess material characteristics.

Adaptive Energy and its partner FORCE Technology have designed and deployed custom-built ultrasonic immersion tank systems for specialized applications. Offering automated scanning capabilities, these solutions have proven to be more effective and efficient than manual or other scanning approaches.

With the immersion method, both the material and the transducer face are immersed into the water, and the scanning process is partially automated, eliminating the need for direct contact with the test material during inspection.

Some applications of ultrasonic immersion testing include:

- Aluminum billets, tubing, and forgings
- Steel forgings
- Metal alloys including INCONEL[®], vanadium and stainless steel
- Ceramics and polymers
- Tube weldments

Tanks can be constructed in a wide range of sizes to suit the dimensions of the items being tested. For example, Adaptive Energy built a customized ultrasonic immersion tank system with a volume of 2,400 liters, and constructed deep immersion tanks for evaluation of very large parts such as metal billets.

Surround-Sound: Multi-Axis Ultrasonic Scanners and Turntables

Immersion tanks typically rely on a multi-axis scanner device to allow inspection of an object from multiple angles. For one customer, Adaptive Energy constructed a system equipped with a five-axis scanner, a turntable, and two special pipe scanners, allowing 360-degree inspection of the test items.

The customer—a heavy manufacturing firm—uses the five-axis arm to scan most objects that it needs to inspect. The arm can position the ultrasonic probe in the X, Y, and Z direction in combination with probe tilt and skew. The system is designed to scan multiple objects, placed on the tank bottom, without user intervention. To facilitate the placement of the components, the tank bottom can be raised and lowered. Additionally, a turntable can be used together with manipulation of the scanning arm to scan rotary symmetric objects.

For scan data acquisition and control, the immersion tank is equipped with FORCE Technology's P-Scan System 4, with a PSP-4+ processing unit. It is possible to program the scanner to follow the shape of an object by using information from a CAD file or by measuring the shape of the object using a laser distance sensor.

Even when testing very large components, customers need ultrasonic scanner systems that are finely tuned to capture detail as small as one 64th of an inch (0.015") or even smaller. The P-Scan software systems that Adaptive Energy deploys enable data collection and analysis at this high degree of sensitivity.

Customer Application: High Performance Materials & Components

The ultrasonic immersion tank approach has proved highly effective for a range of testing applications. For example, it can verify that raw materials such as metals are free of defects, and it can identify flaws in extruded, cast or forged components. Users of the immersion evaluation method include national research laboratories, manufacturing firms and product testing laboratories.

One Austrian producer of high-performance materials uses their custom-built immersion tank to inspect components produced from a number of special alloys that are made with materials such as copper, chromium and tungsten, and sometimes carbon fiber composites. The different components are fused together using a variety of techniques; ultrasonic scanning is used to examine the fusion bonds. The components have a great variation in size and shape and many of the components



Ultrasonic deep immersion tank for evaluating very large objects

also have embedded curved pipes that add to the complexity of the structures. The multiple modes of operation offered by the immersion tank system enable the company to thoroughly inspect all of these components.

Customer Application: Forged Pipeline Flanges

A Mexican steel forging firm uses a large, tailor-made immersion tank scanner for examination of large pipe flanges manufactured for the oil industry. Quality requirements for pipe flanges are very high: they are typically used to reinforce high-pressure points in a pipeline such as pipe joints, or to seal the end of a piping system.

Pipelines can extend for thousands of miles through every climate from arctic to tropical, so temperature conditions can vary widely. The flanges must perform reliably under a broad range of parameters to avoid failure or leaks. Any pipeline leak means, at a minimum, expense and time for a crew to conduct repairs in the field. In more serious scenarios, a leak can mean hundreds or thousands of barrels of oil spilled, representing lost revenue along with more severe negative environmental, community and public relations impacts.

To ensure the quality of the pipe flanges at production-line volumes, the company was looking for a high-precision automated inspection solution as an improvement over their current manual ultrasonic inspections. A large, seven-axis immersion tank scanner was designed and built. It is capable of performing ultrasonic examination from both the inside and outside of the flanges. Because the flanges come in multiple different complex geometries, they must be scanned with an array of six transducers shooting in six different directions.

Using the P-Scan 4+ ultrasonic inspection system, examination of the flanges is performed with all transducers in all directions at the same time. By consolidating inspection of all angles into a single operation, the system saves the company significant inspection time, especially if reportable indications are present. Integrated P-Scan software collects and automatically analyzes scan data, providing real-time indication of any possible areas of irregularity.

Some of the benefits the customer gained from this solution include:

- **Considerable quality improvement**—Even small indications of flaws are automatically detected and registered by the scanner system, which previously could be very difficult and time consuming to detect with manual ultrasonic scanning
- **Time saved on inspections**—The ultrasonic scanning system can inspect a pipe flange quickly and efficiently while operated by a single technician. The previous manual scanning regimen took many more man hours, and every reportable indication had to be individually measured and documented. The P-Scan software performs measurement and documentation automatically
- **Improved employee productivity**—Manual testing often required inspectors to endure awkward and uncomfortable positions while running scan equipment by hand across each area and angle of the forged pieces. With the immersion tank solution, this manual activity is eliminated



Tank and scanner assembly for inspecting metal forgings, prepared for shipping

Customer Application: Large-Scale Steel Components

Adaptive Energy has also designed and built a deep immersion scanning system to allow one manufacturing customer to scan extremely large parts that would be difficult and time consuming to inspect using other methods. For example, this large tank has been used to inspect extrusion pipe by rolling it in the water to do an integrated helical scan, and to evaluate large steel bearing plates for flaws such as cracks and inclusions after casting.

Conclusion

As these examples demonstrate, the flexibility and efficiency offered by immersion tank scanning methods can solve a wide range of complex ultrasonic inspection challenges. Customized tank assemblies and scanner solutions can be designed to meet the need for accuracy, speed and reliability, combined with ease-of-use and automatic data documentation.

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About Adaptive Energy

Adaptive Energy creates customized, non-destructive material evaluation solutions to address mission-critical, time-sensitive testing needs. By combining the latest digital radiography, computed tomography, and ultrasonic imaging technologies with innovative mechanical and robotic assemblies, Adaptive Energy's integrated systems offer rapid deployment, are easy to learn and maintain, and perform reliably under pressure.

Working collaboratively with organizations in the aerospace, automotive, energy, petrochemical, defense, infrastructure, and materials industries, our experts develop optimized solutions for flaw and crack detection, composite delamination, weld inspection, hardness testing, custom radiation enclosures and overhead gantry systems, and more.

Adaptive Energy is also the exclusive distributor in the U.S. and Canada of FORCE Technology's P-Scan ultrasonic scanners, including the P-Scan Stack with Phased Array, a next generation automated inspection system.

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