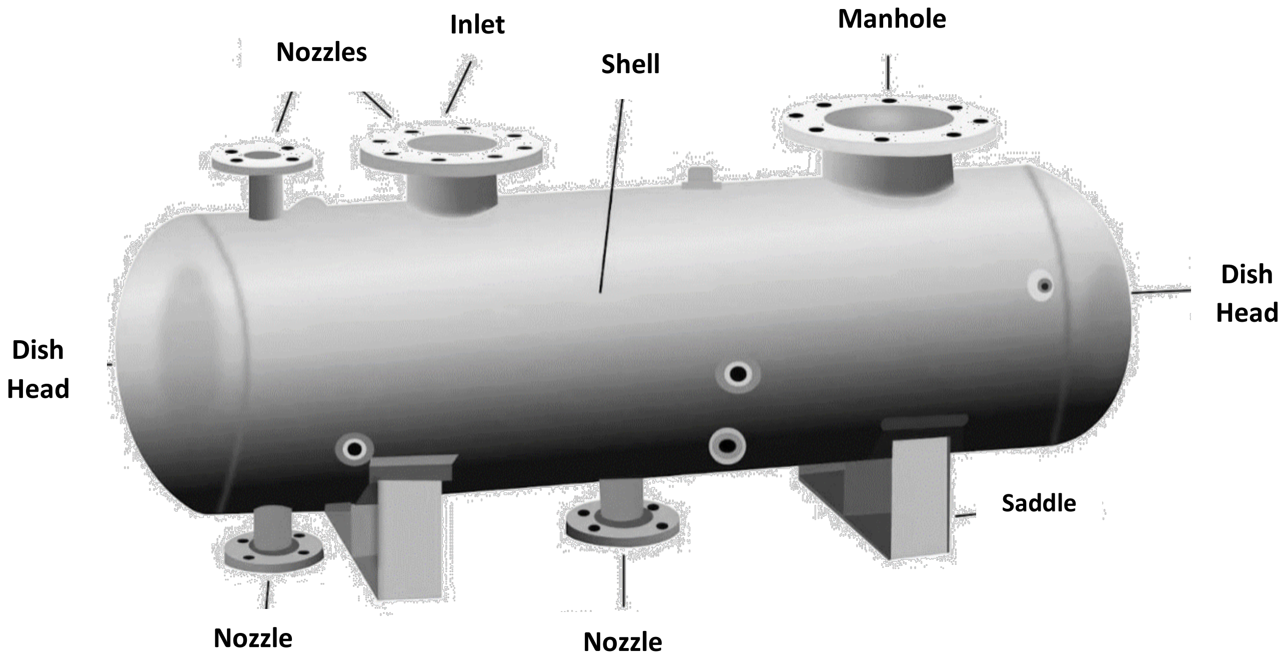
Pressure Vessels
Inspection Challenges

Onur ÖZUTKU
Master's Degree Mechanical Engineer
Ankara,Turkey
Milangaz - LPG Terminal Manager.

What is Pressure Vessel? When is it Required inspection? What are the inspection challenges?



Pressure vessels are critical components used in various industries, including oil and gas, chemical manufacturing and power generation. Their primary function is to contain gases or liquids at high pressure, so their integrity is essential for safety and operational efficiency.

However, the inspection of these vessels presents several CHALLENGES that must be addressed to ensure compliance with safety regulations and prevent catastrophic failures.

Complex Designs and Configurations.

Pressure vessels come in a variety of shapes and sizes, often with complex geometries. These designs can include nozzles, flanges and internal components that make access and inspection difficult.

INSPECTORS must be familiar with the specific design features to identify potential failure points, which can vary significantly from vessel to vessel.

Inspection, testing, involves non-destructive tests that ensure the integrity of a new pressure vessel or on previously installed pressure equipment that has been altered or repaired.

In the early days of pressure vessels, many pressure vessels were over-pressurized, and they would explode. This problem was part of why the American Society of Mechanical Engineers (ASME) formed. This body came up with specifications to govern the way pressure vessels are manufactured and maintained. Today, the ASME is still responsible for establishing standards for pressure vessels in the U.S. Other countries have their own standards for pressure vessels.

There are two standards that every manufacturer and user of pressure vessels should be aware of:

- ASME Section VIII: ASME Section VIII covers the requirements for both fired and unfired pressure vessels, including how they're designed, the way they're fabricated, how they should be inspected and tested and what's required for their certification.

- API 510: Another relevant standard to be aware of is API 510, which is an inspection code from the American Petroleum Institute. This standard specifies how inspections, repairs, alterations and other activities should be carried out on pressure vessels and pressure-relieving devices.

Deterioration and Wear Over Time

Pressure vessels are subject to wear and tear due to the harsh conditions in which they are often operated, including extreme temperatures and corrosive environments. Over time, materials can deteriorate, leading to problems such as corrosion, cracking and fatigue. INSPECTORS must use advanced techniques such as ultrasonic testing, radiography or acoustic emission to detect these subtle signs of deterioration, which may not be visible to the naked eye.

Access Restrictions

Many pressure vessels are in areas that are difficult to access, whether due to their size, location within a plant or the need for scaffolding. This can complicate the inspection process, requiring additional time and resources to ensure a thorough assessment. INSPECTORS often must rely on remote inspection technologies, such as drones or robotic devices, which can further complicate the inspection process.

Regulatory Compliance

Pressure vessel inspections must comply with strict industry standards and regulations, such as those set by the American Society of Mechanical Engineers (ASME) and the National Board of Boiler and Pressure Vessel Inspectors. Keeping up with these regulations can be a challenge, especially for facilities that operate in multiple jurisdictions with different compliance requirements.

Interpreting Inspection Results

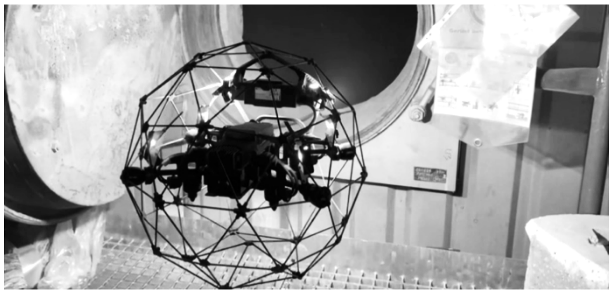
Interpreting inspection results can be complex. Data from various non-destructive testing (NDT) methods must be accurately analyzed to determine the condition of the vessel. MISINTERPRETATION can lead to incorrect conclusions about the integrity of the ship, potentially compromising safety.

Scheduling and Downtime

Pressure vessel inspections often require equipment to be taken offline, resulting in production downtime. SCHEDULING INSPECTIONS without disrupting operations can be challenging, especially in plants that operate continuously. Balancing safety with operational efficiency is a critical management consideration.

Technological Advancements

As inspection technologies evolve, staying current with the latest methods and equipment is essential for inspectors. While advanced tools can improve accuracy and efficiency, they also require ongoing training and investment. FACILITIES must weigh the benefits of new technologies against the COSTS and potential DISRUPTIONS to operations.



Human Factors

Human’s factors play an important role in the inspection process. The EXPERIENCE and TRAINING of inspectors can influence the outcome of an inspection. Ensuring that personnel are trained and competent in the use of inspection tools and the interpretation of results is critical to maintaining safety standards.

Conclusion

Inspecting pressure vessels is a complex task with many challenges, ranging from designs and access to regulatory compliance and technological advances. To ensure the efficiency of these critical asset, it's essential that organizations invest in proper training, adopt inspection technologies to safety and regulatory compliance. By addressing these challenges head on, industries can mitigate risk and improve the reliability of their pressure vessel operations.

Advanced NDT used for PRESSURE VESSEL internal & external Inspection!

Most common methods are Phased Array UT, Automatic UT Corrosion Mapping, Acoustic Emission, Pulsed Eddy Current, Short Range guided wave. In these tests, you will have a permanent record and digital report for corrosion assessment. Defects such as corrosion, cracks, decrease in wall thickness or gaps in internal structures are identified in ferritic and austenitic steels, aluminum alloys, nickel, copper and titanium alloys during production or usage. NDT methods can change depending on the PROCEDURE, SIZE, THICKNESS, and STRUCTURE of the object need to inspect.

Ultrasonic Thickness - Grids Measurement

UT Grid scan with spot digital reading & A-scan.

The portability of the testing equipment allows for on-site inspection and results are instant. If a problem has been detected by the technique, additional non-destructive testing methods can be used to further investigate the findings.

Manual point thickness measurements using conventional ultrasound (UT) is a widely used technique for monitoring corrosion in many infrastructure applications. This however can lead to inconclusive inspection data due to minimal coverage of large areas, operator variability, lack of pitting or localized corrosion detection, and inadequate data reporting and analysis.

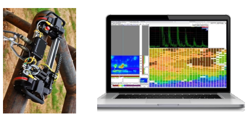
Automatic UT Mapping

AUT is using mechanical scanners with magnetic wheels to only adhering purposes to locate inherent defects within a given material. AUT is the term used to describe corrosion mapping inspections, pulse-echo weld inspection, Phased Array and Time of Flight Diffraction.

Typical Automated Corrosion mapping systems can inspect 20-30 sq. meters per standard workday. The benefit of using the automated imaging systems allows a picture (C-Scan Image) quickly identifies any significant reduction in wall thickness.

Automated Corrosion Mapping Ultrasonic scans of materials, uses a range of colors to represent the thickness range of part being inspected, typically blue colors are used to represent nominal wall thickness with orange and red colors used to indicate significant wall reduction.

Mapping of pipelines for follow up of Smart Pig surveys and Long-Range UT (LRUT) programs allows accurate assessment of localized areas of concern. Due to the speed of modern systems considerable coverage can be completed daily. If you have a critical system and you require 100% coverage for process reliability, then this is the solution you require.

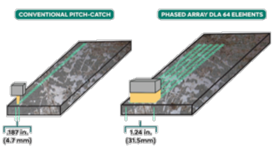


Phased Array UT

Inspect large surface areas quickly with high resolution. Typically, a thickness reading is performed every 1 mm2, which represents 500 more sample points than conventional ultrasound. This high resolution makes it possible to detect small, localized indications, such as corrosion pits, and it enables the operator to profile the shape of the corroded area.

The data can then be used to perform corrosion assessments according to ASME B31G and other applicable standards.

Multiplexing, sometimes called an electronic or linear scan, is used to perform corrosion monitoring. The sensor consists of a long-phased array probe, 25 –100 mm (1 – 4 in.) with between 32 and 128 elements. A small group of elements, defined as the active aperture, is activated to generate an ultrasonic beam propagating normal to the interface. This group of elements is then indexed using electronic multiplexing, creating a true physical movement of the ultrasonic beam under the array with an index as small as 1 mm (0.040”). The electronic indexing is performed so fast that a 4-inch (100 mm) line length is covered by the ultrasonic beams in milliseconds. The travel time of these beams is used to determine the component’s thickness at each acquisition point.

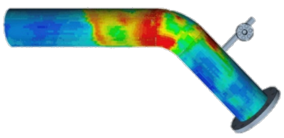


Pulsed Eddy Current

PEC technology does not require direct contact with a test object nor specific surface cleaning, making inspection fast and easy even at high temperatures and on offshore wells.

Pulsed Eddy Current readings conducted many times at the same location can be reliably reproduced regardless of casing, coatings, or insulation. PEC technology provides results with a plus/minus 10% accuracy for corrosion detection and a plus/minus 0.2% accuracy rate for corrosion monitoring. Moreover, Pulsed Eddy Current inspections can be successfully and easily carried out at temperatures ranging from -100° C to 500° C (-150°F to 932°F).

Pulsed Eddy Current technology is based on electromagnetics and provides average wall thickness values over the probe footprint area. It measures and compares the percentage variation in average wall thickness throughout an object. Pulsed Eddy Current can be effectively applied for corrosion detection and monitoring on pipes and vessels made of carbon steel or low-alloy steel without contacting the steel surface itself. PEC technology allows measurements to be made through insulation, concrete, or corrosion barriers.



Acoustic Emission

When a material with defects is subjected to mechanical stress or load, it releases energy. This energy travels in the shape of high-frequency stress waves. These waves or fluctuations are obtained with the utilization of sensors which in turn transforms the energy into voltage. This voltage is electronically overstated with the utilization of timing circuits and later refined as acoustic emission signal data.

When a structure is subject to an external stimulus (change in pressure, load, or temperature), localized sources trigger the release of energy, in the form of stress waves, which propagate to the surface and are recorded by sensors.

Sources of AE vary from natural events like earthquakes and rock bursts melting, twining, and phase transformations in metals. In composites, matrix cracking and fiber breakage and debonding contribute to acoustic emissions.