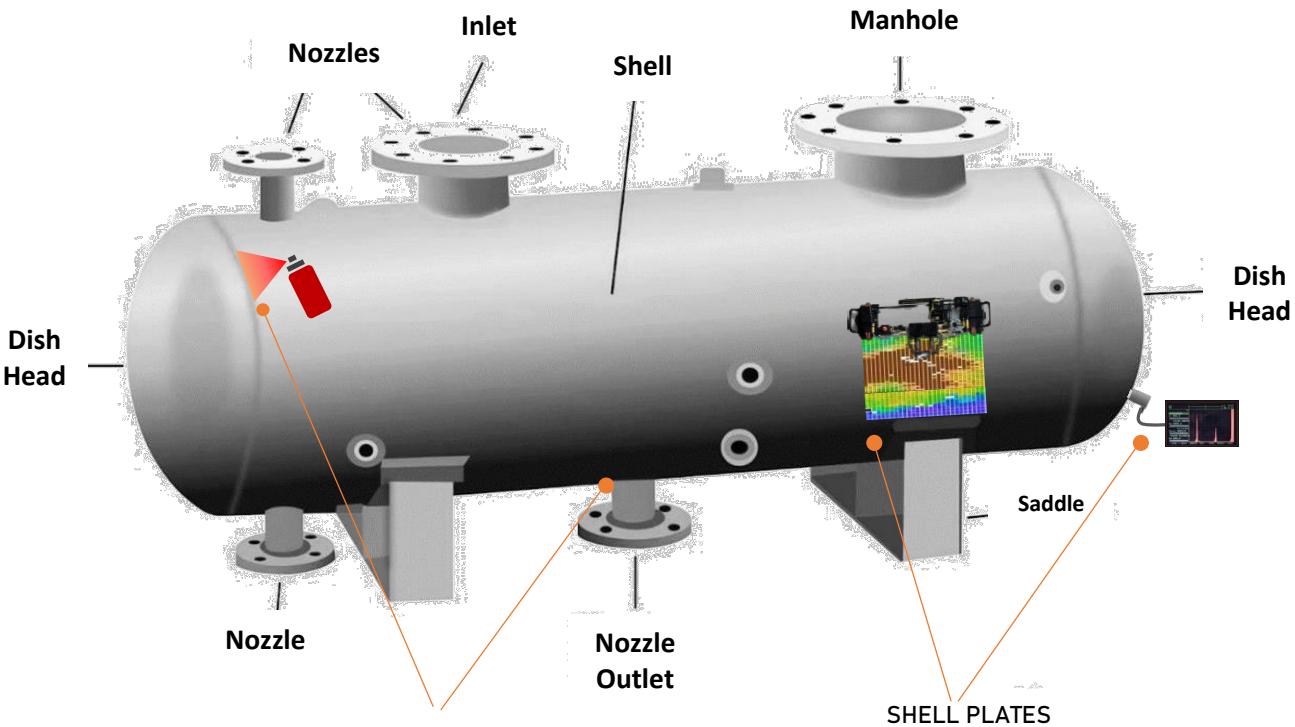
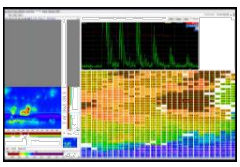
HOW TO INSPECT PRESSURE VESSEL?

Pressure Vessel Integrity

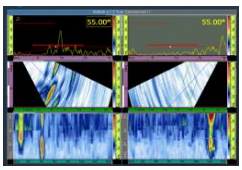


WELDS
- MT/ PT
- UT FD / Shear Wave
- Phased Array (PAUT)
- EC for surface cracks

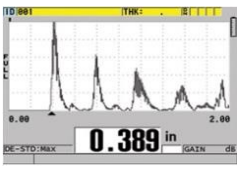
SHELL PLATES
- Automatic UT Corrosion Mapping
- UT with A-SCAN / UT Grid Scan
- Visual Test / PAUT for corrosion
- Pulsed EC for insulated Vessels



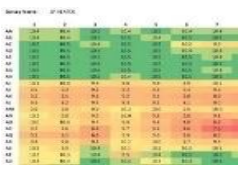
AUT scan



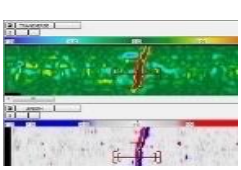
PAUT scan



UT scan



UT grid scan



ECT scan

PRESSURE VESSEL INTEGRITY

What Is Pressure Vessel?

Pressure vessels are containers that hold liquids or gases at a pressure that differs substantially from the outside pressure. Pressure vessels can be found in homes and industrial facilities all over the world. Some applications of pressure vessels include in steam boilers, engine cylinders and storing chemicals or petroleum products. These examples only begin to scratch the surface, as pressure vessels have nearly endless applications.

While pressure vessels are extremely useful and likely will continue to be used indefinitely into the future, they can be problematic. The difference between the pressure inside a pressure vessel and the pressure outside makes for a potentially hazardous situation. Pressure vessels have long been known to be dangerous and have caused fatal accidents in the past. Because of this, the way pressure vessels are made and used is specified by engineering authorities, and these authorities are supported by governmental legislation.

These standards also specify the need for testing and include guidelines for pressure vessel inspection procedures. The inspection of pressure vessels is both required and smart practice for anyone who wants to avoid an accident that could result in unplanned downtime, damaged equipment and potentially fatal injury to workers.

In this article, we will learn more about different types of pressure vessels, what pressure vessel inspections consist of and when they are required as well as different methods of testing.

Types of Pressure Vessels

Pressure vessels are designed differently based on their end application, though they all tend to look similar and include the same basic parts. Pressure vessels are typically cylindrical with rounded edges or are spherical. That is because these shapes avoid stress raisers.

Common appendages include a pressure gauge, fusible plug and a differential pressure switch, which causes the compressor to come on when pressure drops and to turn off when pressure is at a max. Most pressure vessels are also equipped with a manhole, hand hole or sight hole, which is for general cleaning and inspection. You may also find a condensate drain on the bottom of some pressure vessels. This feature either automatically drains or allows for manual draining of moisture. This is a helpful feature since, depending on the material; moisture in a tank can cause corrosion or pitting.

Beyond their appearance, pressure vessels carry out different functions. One basic way of classifying pressure vessels is to divide them into two categories — fired and unfired, or non-fired. A typical example of a fired pressure vessel would be a boiler. Unfired pressure vessels are not connected with any steam generation or anything with a flame.

We can further divide pressure vessels into a few different types. Though there are some outliers**, the most common pressure vessels fall into three types — storage tanks, heat exchangers and process vessels:**

1. Storage Tanks

Storage tanks are the most common type of pressure vessel. They come in various shapes and sizes, but they are all designed to store liquids and gases under pressure. They might hold fuel oil, liquefied hydrogen or compressed natural gas or other materials that are valuable in industrial applications. These tanks are often made from carbon steel, though they may be coated in a different material on the inside.

2. Heat Exchangers

Heat exchangers are the second most common type of pressure vessel. Heat exchangers transfer heat between mediums, often liquids. This way, heat exchangers are useful for both cooling and heating processes. Heat exchangers can be found in furnaces in homes all over, but they are also essential to processing and manufacturing plants. A common type of heat exchanger used in chemical processes is the shell and tube. With this type, within a pressurized shell, one liquid runs through tubes while the other liquid flows over the tubes, causing heat to transfer from one liquid to the other.

3. Process Vessels

Process vessels, as the name suggests, are used to facilitate a process in a controlled environment. This process is typically one-step in a more extensive process. This sub-process could involve combining materials, separating materials, agitating a mixture, breaking down products or removing an element from a product. Process vessels are designed and constructed with the specific process they are intended for in mind. Sub-types of process vessels include Drums, Reactors, Columns & Gravity separators.

What Is Pressure Vessel Inspection & When Is It Required?

Pressure vessel inspection, or pressure vessel 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.

Certain industries and government agencies may have their own stringent standards that govern the requirements for pressure vessels. For example, NASA uses pressure vessels and systems to store gases and liquids that are used in launches and on-orbit operations. Once these vessels are in space, they usually can't be serviced, so it's crucial that they are rigorously examined before they leave Earth. Therefore, NASA has its own standards it abides by.

Manufacturers should keep all the relevant standards in mind when designing and building pressure vessels. However, just attempting to follow the standards isn't enough. There needs to be a way of confirming that every pressure vessel that enters the market is safe. This is where pressure vessel inspection comes in. There are various tests a professional can employ to make sure a pressure vessel meets the necessary pressure vessel testing requirements and is ready to be used. For example, the inspector must check that the vessel's shell is thick enough to keep the pressure in.

After a pressure vessel moves from its initial manufacturing and testing to its end application, it may undergo alterations or repairs. Whenever something like this happens, the pressure vessel needs to be inspected again to see whether it still meets all requirements.

While the two scenarios above are times when pressure vessel inspections are required, a vessel could experience issues over time that could cause it to break down and no longer be safe, especially if it is not properly maintained. Here, again, pressure vessel inspection plays an important role.

If there are any issues that could lead to more serious problems, an inspector can point these out, so the necessary maintenance is carried out. This can prevent a pressure vessel from failing and causing severe injury to workers and damage to a manufacturing plant or other type of facility.

PRESSURE VESSEL INTEGRITY

Methods of Pressure Vessel Testing

Pressure vessels need to be structurally sound to maintain their internal pressure and not to allow whatever material is contained inside to leak out. Testing is intended to ensure that pressure vessels do not contain any flaws like punctures, cracks or loose connections that could compromise their efficacy.

Two primary types of tests that are performed on pressure vessels include **hydrostatic** and **pneumatic** tests. The key difference between these two types is that hydrostatic testing uses water as the test medium, and pneumatic testing uses a non-flammable, non-toxic gas like air or nitrogen.

A concern with pneumatic testing is that, if a fracture occurs during testing for some reason, it could lead to an explosion. This makes hydrostatic testing a safer option since the volume of water does not rapidly increase when it is suddenly depressurized. However, there are situations where pneumatic testing is a viable option.

Hydrostatic testing involves filling a vessel entirely with water, pressurizing it up to one and a half times its design pressure limit and then watching for any leakage. Adding a tracer or a fluorescent dye to the water inside can make it even easier to see where there may be leaks. Hydrostatic testing could cause damage to a pressure vessel if the water is pressurized too much or if the pressure causes a small fracture to spread rapidly.

Beyond these basic types of testing, OSHA identifies **five non-destructive testing (NDT),** also called non-destructive examination (NDE), methods that are widely used on vessels: VT, PT, MT, RT, UT

Pressure Vessel Testing Benefits

Pressure vessel testing, as we've seen, is required at certain stages, but it's also something all manufacturers and end users should want to prioritize since it's so critical to maintaining their operations and people's safety. If a pressure vessel holds a poisonous gas, a rupture could allow for a dangerous gas leak. Even if the material inside is not poisonous; a ruptured vessel could lead to an explosion or a serious fire.

An event like this could quickly bring your operations to a halt. Consider what operations in your business are, in some way, dependent on a pressure vessel. Now imagine those operations ceasing until the pressure vessel is replaced. Unplanned downtime can result in a great financial loss.

An accident from a pressure vessel could also severely damage equipment within the vicinity of the pressure vessel. It could cost hundreds, thousands or even millions of dollars to replace the damaged equipment. And, of course, any equipment out of commission will add to the issue of unplanned downtime.

An even graver consequence than financial loss is if any workers are poisoned or caught up in an explosion or fire. Employers are responsible for maintaining a safe working environment for their workers, and an injury or death due to a faulty pressure vessel can seriously compromise this environment.

None of this will seem important if you assume your pressure vessels are in good shape. While this is hopefully the case, you cannot know for sure unless your vessels are tested. The results of a pressure vessel inspect may surprise you. According to OSHA, recent pressure vessel inspections have revealed the fact that many pressure vessels in workplaces are cracked or damaged.

Regular inspections can make all the difference in preventing a dangerous failure. Pressure vessel inspection frequency depends on a variety of factors, but a general rule of thumb is that **you should have your pressure vessel inspected every five years**. **These inspections should be thorough and involve a visual inspection, a hydrostatic pressure test, a thickness evaluation, a stress analysis and an inspection of any pressure release valves.**