

# **HAZARDS & SAFETY CONCERNS DURING PNEUMATIC TESTING OF PRESSURE PLANTS**

## **Introduction**

Chemical Plant Equipments like Pressure Vessels, Heat Exchangers, Columns, Pipe Lines etc. need to be tested for leak tightness at various stages like completion of fabrication, before commissioning and at regular intervals during plant operation to ensure adherence to Statutory regulations and Safe operation. Normally employed methods of testing are Hydrostatic and Pneumatic tests in addition to rarely used test like "Helium Test" etc.

Pneumatic test is widely used to achieve minimum down time and economy and convenience of testing as compared to hydrostatic tests. It is also useful to detect very fine leak paths which may not be found in Hydrostatic Test. However it is not as safe as hydrostatic tests for reasons enumerated below.

## **Hazards involved in Pneumatic testing.**

It is well known fact that as water cannot be compressed (Boyles law), the energy stored in a vessel under hydrostatic pressure is very very less as compared to that of vessel under same pressure with Air. This stored potential Energy gets converted to kinetic energy at the time of rupture and that is what makes pneumatic test very dangerous.

## **What is pneumatic test? Is it permitted by codes?**

- ▶ It is an alternative method of pressure test in lieu of Hydrostatic test, allowed by codes at certain conditions, by using air or any other gas as test media.
- ▶ It is mostly recommended only for equipments already tested and proved safe by hydrostatic pressure test.
- ▶ Preferably done only for low pressure applications & vessels having low volumetric capacity.
- ▶ Pneumatic Test pressure is always less compared to hydrostatic test pressure. ( as per ASME Sec. VIII Div. 1 pneumatic test pressure is 1.1 times of design pressure where as hydrostatic test pressure is 1.3 times of design pressure)
- ▶ Leakages are identified by soap water application on weld joints and not by observing the pressure gauge.

## **What are the risks involved with pneumatic test ?**

- ▶ Air / gas used for pneumatic test is compressible to large extent and has very high potential energy stored when compressed.
- ▶ Any minor leak path can lead to a rupture and blast within no time releasing total energy with an impact of sudden explosion.
- ▶ Time gap between identifying a leakage and failure is very small making it almost impossible to take remedial action.
- ▶ Damages associated with failure are uncontrollable and huge.


## **Why Hydrostatic test is safer as compared to Pneumatic Test ?**

- ▶ Water or liquid used for pressure test are not compressible compared to air or gases.
- ▶ Energy stored is very less.
- ▶ Small leak will reduce gauge pressure immediately which does not happen when Air is the test medium.
- ▶ It has less potential energy hence damages are mostly limited to near by area.
- ▶ There is a possibility that you can take remedial action once minor leakages are noticed before total failure occurs.
- ▶ Leakages are easy to detect incase of hydrostatic test

**A GENERAL COMPARISON OF HYDROSTATIC TEST Vs. PNEUMATIC TEST.**

<b>Hydrostatic Test</b>	<b>Pneumatic Test</b>
<ul style="list-style-type: none"> <li>▪ Test pressure normally 30 % above the Design pressure (Refer ASME Sec. VIII Div. 1 UG 99.)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Test pressure normally 10 % above the Design pressure (Refer ASME Sec. VIII Div. 1 UG 100)</li> </ul>
<ul style="list-style-type: none"> <li>▪ Recommended for high pressure applications</li> </ul>	<ul style="list-style-type: none"> <li>▪ Recommended for only low pressure applications.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Test media used is not compressible by pressure application</li> </ul>	<ul style="list-style-type: none"> <li>▪ Test media is compressible by pressure application</li> </ul>
<ul style="list-style-type: none"> <li>▪ Energy stored per unit volume of water under pressure is very negligible.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Energy stored per unit volume of compressed air is very high</li> </ul>
<ul style="list-style-type: none"> <li>▪ Recommended to prove the strength of equipment</li> </ul>	<ul style="list-style-type: none"> <li>▪ Recommended mainly for leak test on equipments which have already proved their strength by Hydrostatic test.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Needs thorough cleaning after test to eliminate moisture especially for services which are reactive to moisture / fluids</li> </ul>	<ul style="list-style-type: none"> <li>▪ Easy to clean after testing.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Normally water is used as medium of test</li> </ul>	<ul style="list-style-type: none"> <li>▪ Air, Nitrogen, Argon etc. used for pneumatic test</li> </ul>
<ul style="list-style-type: none"> <li>▪ Pressure Relief valves are recommended to control sudden increase in pressure during testing.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Pressure relief valves are must during test to ensure no over pressurisation</li> </ul>
<ul style="list-style-type: none"> <li>▪ Needs less safety distance to cordon off from man entry during test period</li> </ul>	<ul style="list-style-type: none"> <li>▪ Needs large area to be cordoned off during testing as accidental release of pressure travels long distance due to high energy stored.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Chances of equipment failures are less</li> </ul>	<ul style="list-style-type: none"> <li>▪ Chances of equipment / test apparatus failures are high</li> </ul>
<ul style="list-style-type: none"> <li>▪ Weight of equipment with test medium as water is high hence special attention should be given to floor and supporting arrangements.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Weight of equipment with test medium as air is comparatively less</li> </ul>
<ul style="list-style-type: none"> <li>▪ Needs verification and examination of joints and connections before testing</li> </ul>	<ul style="list-style-type: none"> <li>▪ Needs very careful and specific checking of weld joints thoroughly before testing (Refer ASME Sec. VIII Div. 1, UW – 50)</li> </ul>
<ul style="list-style-type: none"> <li>▪ Test media can be reused and transferred to other place after testing.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Test media can not be transferred or reused after testing.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Skilled and semi skilled personnel can carry out test.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Needs involvement of senior experienced staff to monitor test.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Recommended where large volumes are to be tested at same time ( example pipe lines )</li> </ul>	<ul style="list-style-type: none"> <li>▪ If pipe lines are tested should be done with small segmental lengths at a time.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Damages due to failures are less compared to failures in pneumatic testing</li> </ul>	<ul style="list-style-type: none"> <li>▪ Damages due to failure in testing are very huge and extensive.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Is a regular practice and safe procedure and can be followed in any work site</li> </ul>	<ul style="list-style-type: none"> <li>▪ Needs special attention and safety precautions.</li> </ul>
<p><b>A WELL WRITTEN DOWN PROCEDURE IS MUST FOR BOTH BEFORE CONDUCTING TEST</b></p>	

**Some Case Studies of wrong practices adopted in Industry, its consequences and recommended procedures.**

<u>Sr. No.</u>	<u>Practice</u>	<u>Consequences</u>	<u>Recommendation</u>
1.	In a Fabrication Shop, During Hydrostatic test of a Pressure Vessel, when pump was not capable of generating the required pressure, gas cylinder was used to boost the pressure which could not be controlled.	The pressure went too high, bolting of one manway sheared, man way cover flew away, and hit the Inspector who died on the spot.	Test Pressure should be achieved only with water. No air should be left in the vessel or should be used to increase hydrostatic pressure. Pressure Relief arrangement should be provided
2.	In a large petrochemical plant, a 3.5m dia. vertical storage tank with flat top & having manway and few nozzles on top cover was to be tested with a very small air pressure to check some instruments. By some error, the pressure increased and as result, the whole top cover sheared from the shell and flew away like a projectile and fell around 130 meters away	There was considerable damage to other installation however, no human lives were lost.	For small pressure, U tube Monometer should be used instead of pressure gauges. Take more care to ensure no over pressure is possible. Use certified safety relief valve as additional safety.
3.	From a dairy plant, one used condenser was sent for repairs, The fabrication shop carried out pneumatic test in place of Hydraulic test for shell side to detect tube to tube sheet leakage.	The condenser burst in the shop seriously injuring number of workers. Few equipments in the shop were also damaged due to explosion.	A used equipment should first be tested only with water. After that a pneumatic test at reduced pressure may be taken if necessary.
4	A freak incident happened in Brazil during pneumatic testing of piping connected to an atmospheric Tank. Pipe line was not fully isolated from tank although there was a valve in between, but not closed and blanked fully, allowing air to enter the tank which uprooted the tank and the tank was thrown on top of near by plant building as shown in the actual picture.		

## AUTHOR

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