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Hydro-test Method to Detect Leaks in Pressure Vessels at PT DIHI

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ABSTRACT

In the manufacturing of a device, several types of testing are performed. Testing must be done to ensure that the designed device is completely safe for long-term use and meets existing standards. There are several tests conducted, one of which is the Hydrotest. This Hydrotest is conducted to test whether the designed device experiences leakage, particularly at weld joints, by filling pressurized water into a test device and holding it for a certain period. In this study, we aim to conduct a Hydrotest on a Pressure Vessel to see if the designed Pressure Vessel experiences leakage in its construction. From the results of the testing conducted, it was found that the designed Pressure Vessel did not experience leakage, particularly at each weld joint. Based on the Pressure and Temperature Chart Recorder, the graph indicates that there is no pressure drop, and the temperature remains within a safe range.

Keywords: *Hydrotest, Pressure Vessel, Pressure, Temperature*

1. INTRODUCTION

Every company operating in the industrial sector, particularly in the production or manufacturing of a device, undoubtedly involves several types of testing. The tests conducted depend on the needs of each company, and the tests are certainly carried out based on existing standards. Testing is done with the aim of ensuring that the device produced is safe and can be used for a certain period. Because if testing is not done, it is unknown whether the device produced is safe or not. This testing is part of the Quality Control procedure that ensures that the products or devices produced have high quality[1].

There are various types of testing in the manufacturing some device, but in general categorized into two types: Destructive Test and Non-Destructive Test. In this study, a Hydrotest was conducted. This test belong to the category of Non-Destructive Test. Hydrotest uses a fluid medium to determine whether there is leakage or not in a device or system. Additionally, Hydrotest tests the strength of the material used in the device's construction. Typically, Hydrotest is performed on heavy equipment such as Pressure Vessels, Heat Exchangers, Storage Tanks, and others[2].

In this study, a hydrotest was conducted on a Pressure Vessel. Pressure Vessels are common storage devices found in the industrial world. This equipment is widely used for storing liquid gases as well as oils. Since gas is a highly flammable substance, the design of the Pressure Vessel's construction must comply with existing standards. During its operation, the Pressure Vessel receives internal pressure, or internal pressure, external pressure, the weight of the Pressure Vessel itself, and its contents. [3].

The design and manufacturing of pressure vessels are governed by the ASME Boiler and Pressure Vessel Code Section VIII Division I guidelines. Generally, Pressure Vessels are classified into two types: thick-walled and thin-walled. Pressure Vessels are usually treated as thin-walled if the ratio of radius to thickness is 10 or greater. The stress or tension caused by internal pressure on a thin-walled cylindrical Pressure Vessel can be determined using membrane theory, whereas for a

thick-walled cylinder, stress is calculated using Lame's equation [4].

Figure 1. *Hydrotest*

2. METHODOLOGY

2.1. Hydrotest preparation

In this study, the hydrotest will be applied to a horizontal separator type Pressure Vessel with the code D2203 SMR-VSL-001. This Pressure Vessel is an order from the Ministry of Energy and Mineral Resources. In determining the design and specifications, such as the type of material to be used, design data includes Pressure, Temperature, weight or mass, type of inspection, and so on, based on the ASME Section VIII standard. The table below are the specification of the Pressure vessel:

Table 1. Pressure Vessel Spesification

No	Parameter	Result
1	Material	Carbon Steel
2	Pressure Design	670 Psi
3	Temp Design	65° C
4	Weight	10 Ton
5	Length	609,6 cm
6	Width	164,5 cm

Before conducting the Hydrotest on this Pressure Vessel, a pressure test is applied first. Additionally, there are several requirements for doing a hydrotest:

1. Perform checks first such as cleaning the inside and outside from splashes, scale, slag, and others.
2. The pressure gauge must be calibrated beforehand according to existing standards to ensure that the data obtained is more accurate and to minimize the occurrence of errors or inaccuracies in the data, and the gauge used must be within its 6-month validity period
3. Two indicators that show the pressure of the pressure gauge should be used in the test. One connected to the highest location to indicate the correct pressure, and the other connected should be where it can be easily seen by the operator during the test.

Table 2. Pressure Test Report

Certificate Of Pressure Test Report			
Item Name	*Horizontal separator*	*Procedure No*	722301-VD-000-ENG-PRD-002
Project Name	Pembangunan Pipa Transmisi Gas Bumi Ruas Semarang - Cirebon Tahap 1	*Appl. Code*	ASME VIII Div. 1 2021 Edition
Material	SA516-70	Pcs	
Test Side	***Shell Side***		
Design Pressure	47,11 kg/cm2.g/670 PSI.G		
Type Of Test	***Hydrotastic***	***Pneumatic***	
Fluid Type	*Water*	-	
M.A.W.P	47,3 kg/cm2.g/672,60 PSI.G	-	
Test Pressure	61,49 kg/cm2.g/874,38 PSI.G	-	
Test Position	*Horizontal separator*	-	
Test Temperature	*See temperature reading*	-	
Holding Time	120 *minutes*	-	
Result	*Accepted*	-	

After the pressure test is complete, the pressure vessel will then be tested for hydrotest. Hydrotest testing must also be prepared so that everything runs smoothly. Checking must be in accordance with existing standards. In addition, there are several test requirements before going to do a hydrotest, including:

1. This Hydrotest test must comply with the provisions of the ASME Section VIII Div 1 standard, 2021 Edition, and also with the provisions of the request from the company that ordered the product
2. QHSE Division Prepared a safe location and police line prior to the Hydrotest testing.
3. The QC Division must prepare the procedures to be implemented, because there are product owners who come to inspect the ordered devices and get visual to be told. In addition, the measuring instrument must be completely installed and there are no leaks in the valve or hose.

Figure 2. *QC Prepared The Hydrotest*

2.2. Hydrotest Procedure

In every testing process, there are steps or procedures that will be followed from the beginning to the end of the testing. These steps must be carried out correctly so that the testing process runs

smoothly and in accordance with what is desired. There is a Hydrotest testing procedure:

1. Preparations must be complete, the QC department must ensure everything is safe before conducting the testing.
2. Closing all nozzle holes on the pressure vessel and manhole with blind flanges to prevent leakage during the testing process
3. Make sure that all bolts are securely fastened to prevent small leaks.
4. Install all pressure gauges, namely pressure gauge, and temperature gauge. All gauges must also be in a calibrated condition. The tolerance comparison value between the pressure recorder and the pressure gauge should not exceed 1.5.

Figure 3. *Pressure Gauge and Temperature Gauge*

5. Make a hole at the very top of the pressure vessel which is to release air during the process of filling water into the pressure vessel. Then remove the air that settles in the pressure vessel, then fill it with water by compressing all channels and other parts.
6. Pressure is introduced into the shell pressure vessel with a pump where the pressure rate is 1.3 times the allowable max pressure. Then increase the pressure slowly until it reaches the test pressure.
7. Increase the pressure to the MAWP or maximum allowable pressure as long as there is no leakage or deformation of the pressure vessel. After the pressure is increased, then hold the pressure for 10-15 minutes. If there are no leaks and the pressure does not decrease significantly and there is no change in shape after holding for 10 minutes under MAWP conditions, then increased the preasure again by 1.3 MAWP and held again for 1 hour or 60 minutes.

Figure 4. The Pressure rate at Holding Time for more than 1 hour

8. Release the pressure until it reaches MAWP and hold for 10-15 minutes.
9. After that, lower the pressure ratio until the end. Check the overall physical components of the pressure vessel to ensure they are in good condition.

3. RESULTS AND DISCUSSION

After completing the hydrotest testing procedure from start to finish. Then the results obtained can be seen in the table below:

Table 3. Hydrotest Report

Hydrostatic Report Test								
No	*Time*	*Pressure*						*Temperature*
		Recorder		PG-01		PG-02		*Water* (°C)
		kg/cm^2 g	PSI.G	*kg/cm^2 g*	PSI.G	*kg/cm^2 g*	PSI.G	
1	08.00	0.0	0.0	0.0	0.0	0.0	0.0	20
2	08.10	48.5	690	48.5	690	48.6	691.4	20.1
3	08.26	48.4	688	48.4	688	48.5	689.4	20.1
4	08.30	62.2	885	62.2	885	62.3	886.4	20.2
5	08.45	62.2	884.8	62.2	884.8	62.3	886.2	20.4
6	09.00	62.2	884.5	62.2	884.5	62.3	885.9	20.6
7	09.15	62.1	883	62.1	883	62.2	884.4	20.8
8	09.30	62.1	883.5	62.1	883.5	62.2	884.9	21
9	09.45	62.1	883	62.1	883	62.2	884.4	21.2
10	10.00	62.1	882.5	62.1	882.5	62.2	883.9	21.4
11	10.15	62	881	62	881	62.1	882.4	21.6
12	10.30	62	881.5	62	881.5	62.1	882.9	21.8
13	10.48	61.9	880	61.9	880	62	881.4	22
14	10.50	48.5	690	48.5	690	28.6	691.4	22.2
15	11.05	48.5	690	48.5	690	48.6	691.4	22.4
16	11.15	0.0	0	0	0	0	0	22.6

After the testing is done, several data were obtained, including pressure and temperature readings from the beginning to the end of the testing. It can be seen that the hydrotest started at 8:00 am and ended at 11:15 am. Initially, the temperature and pressure were both 0 because the testing had just begun. Then, the pressure increased to 48.5 kg/cm2g. This rate did not jump suddenly or become 48.5. Similarly, the two PG (Pressure Gauges) had the same value.

Next, the pressure that was previously 48.5 kg/cm2.g was increased again by 1.3 MAWP, becoming 62.2 kg/cm2.g, and the pressure was held constant for 2 hours or 120 minutes. If there was no leakage and the pressure remained constant, and the temperature was still within a safe range, then the pressure was reduced by 1.3 MAWP. After the pressure was reduced, the obtained pressure value was 48.5 kg/cm2g, and if there was no leakage. Then proceed to depressurize again to empty the water and air.

The test report is not only in numerical form but also uses a bar chart or temperature and pressure chart. The function of this chart is to record the results of the pressure vessel testing from the beginning to the end of the testing, based on the temperature and pressure values obtained every

minute. The temperature indicator uses a red marker or a horizontal line that can be seen below, which is a horizontal line crossing between blue lines. The blue line mentioned is the indicator that the line is for the recorded pressure or pressure from the beginning to the end of the testing. This bar chart can be seen below:

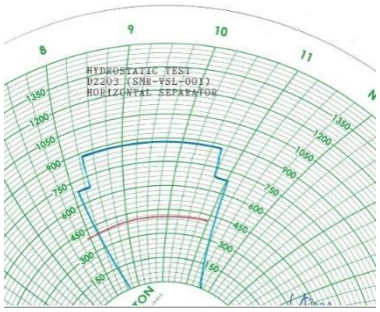

Figure 5. Pressure and temperature chart result

The chart is very important for the report because, as seen from the picture above, the lines mentioned earlier are declared safe by the QC or tester and also the company that ordered the product. If there is a decrease in pressure during the hydrotest process, it can be considered that there is a leakage and repair must be done.

The data above serves as evidence that the pressure vessel is suitable for use over a long period. After all the hydrotest processes are complete, the next step is the blasting and painting or cleaning stage, where rust still adheres to the shell. After the blasting process is complete, the next step is the painting or coating process for the entire body. After the painting process is complete, then waiting for the paint to dry and performing other tasks.

4. CONCLUSION

After completing the hydrotest test on the pressure vessel and obtaining the test results. Then next there are conclusions from the results of this test:

1. Hydrotest testing is very important for products that will store a liquid. But not only for storage, products such as heat exchangers are also hydrotested. This test has benefits such as ensuring that the product used can withstand the pressure in accordance with the calculation, in order to avoid an explosion that is not at all desirable. Then the next benefit is to detect leaks or other damage to the pressure vessel.
2. After the test has been completed, and data is obtained, one of which is the pressure and temperature chart. Based on the bardon chart, the pressure vessel does not leak and is suitable for use. If there is a decrease in pressure from the designed pressure, there is a leak and the leaking part must be repaired.

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REFERENCES

[1] Yuliyarto, & Putra, Y. S. (2014). Analisis Quality Control Pada Produksi Susu Sapi Di CV Cita Nasional Getasan. *Among Makarti, Vol. 7 No. 14*, 79-91.

[2] Prahesti, D. N., Yunus, & Arsana, I. M. (2023). Pengujian Hydrotest untuk Mencegah Kebocoran pada Tube Bundle Pertamina RU III Plaju Palembang di PT. PAL Indonesia. Jurnal Mesin Nusantara, Vol. 6, No. 1, 54-62.

[3] Effendi, R. (2014). Optimasi Kekuatan Horizontal Vessel Menggunakan Analisis Elemen Hingga. *Seminar Nasional Sains dan Teknologi*, 1-7.

[4] Wibowo, A., Lubis, A., & Akmal, J. (2019). Strength Analysis Of Lifting Lug Of Horizontal Cylindrical Pressure Vessel. *Prosiding SNTTM XVIII*, 9-10.