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Analysis of Hydro Test Pressure Variations on A106 Grade B Carbon Steel Pipe Welded Joints with Welding Repair Method

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Abstract

Transportation of oil and gas through oil refinery pipelines is faced with problems, including corrosion problems. Corrosion is a natural phenomenon that occurs in metal materials, where corrosion is a process of material damage due to chemical or electrochemical reactions with its environment. The purpose of this study is the results of the analysis of HydroTest pressure variations on the Welding Joints of Carbon Steel Pipes (carbon steel) A106 Gr.B. In the study did not discuss the occurrence of corrosion and other tests, while the welding process in detail was shown in WPS. This experimental research method uses the Welding Repair Method on welded joints according to the ASME IX, ASME B31.3 standard. The research material is A106 GR carbon steel pipe. B is in the form of a U Tube Seal Deck that has undergone corrosion and damage, where later the fabrication process (pipe repair) especially welding (using SMAW and GTAW) has been determined in PQR and WPS (WPS / CS / EM / ASME / WPxxx). The focus of this research is on stage 9 (hydro testing stage) of the Welding Repair method. Free variables in pressures of 240 Psi, 435 Psi, 690 Psi, and 910 Psi, which have been planned based on the thickness and length of the Pipe joint. Variable fixed temperature test Hydrotest 28^{O}C, holding time holding time (pressurizing) 10 minutes and holding time peak 60 minutes before (depressurizing). The results were obtained that the pressure change was divided into two stages, pressurizing with the highest pressure of 915 Psi is the 4th pressure variation this was obtained from the test observation that there were no leaks in the welded joints and pipe materials in accordance with the acceptance criteria. While the second stage is (depressurizing) with a decrease in pressure or called realese, where successively realese 100%, 75%, 50%, 25%, and 0% at pressures of 915 Psi, 690 Psi, 435 Psi, 240 Psi, 0 Psi with the results of no leakage and observation test results in accordance with the acceptance criteria. So it can be concluded that the welded joints of carbon steel pipes tested using hydrotest, no deformation occurs, there is no change in shape and there are no leaks in the welded joint layer of A106 Gr.B carbon steel pipe.

Keywords: Carbon Steel Pipe, Pressure, Hydrotest, Welding Repair

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1. Introduction

The oil and gas industry plays an important role in today's modern society in meeting the needs of heating, electrical energy and transportation. Despite the importance of the oil and gas industry as an economic and social activity. Transportation of oil and gas through oil refinery pipelines is faced with problems in its maintenance, including problems with offshore oil pipelines, which are constrained by corrosion. Corrosion is a natural phenomenon that occurs in metal materials, where corrosion is a process of material damage due to chemical or electrochemical reactions with its environment. The environment in question can be acidic environment, air, dew, fresh water, seawater, lake water, river water and groundwater.

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Pipe materials that are often used in the oil and gas industry include A106 Gr.B Carbon Steel (carbon steel) metal which can also experience corrosion. In order for the corrosion to be prevented, it is necessary to maintain pipe material, especially in the weld joint pipe. This A106 Gr.B Carbon Steel metal material as offshore oil transportation is subject to corrosion, because the material often comes into contact with seawater, this will accelerate the corrosion rate[1].

Repair and prevention are indispensable to inhibit the rate of corrosion that occurs, with repair procedures that refer to standards, so that the work carried out is structured, systematic, and carried out using good methods and meets the standards. The method of welding and painting (coating) is a method that is often used in PT. XXX. The welding process in pipe repair, of course, is also procedurally necessary to test the welding results carried out such as Visual Test (VT), Penetrant Test (PT), and Hydrostatic Test (HT).

In the Quality Control Division which carries out the inspection / leak test process in the Oil and Gas Pipeline using the hydrotest method. [2]

Hydrotest or Hydrostatic test is a test with a certain pressure using water media as a tester to find out the strength of a material and to find out whether there is a leak or not (usually done on objects that have been connected with a welding system). The purpose of Hydrotest is not only to see leaks in the welding, but also the possibility of leaks in the material itself when the material is made. In the hydrotest process, there are several things that can affect the test results, one of which is because the pressure rises and falls. And the impact on the pipe material results in the density of the material [3].

Previous studies related to this research include:

1. "Multiple Repair Analysis of SA 333 Grage 6 Carbon Steel Material with GTAW Process Against Toughness Hardness, and Microstructure", obtained from the study, namely; The results of the micro-test resulted in a smaller grain size as the number of repairs increased. The number of repairs will increase the percentage of pearlite phases in the HAZ area. From these results it is concluded that the increasing number of repairs will increase the hardness value but will decrease the toughness value of the welding joints and all meet the allowable acceptability [4].
2. In 2020 with a study entitled "The Effect of Air Confined in the Chart Recorder on the PT. Mulia Jaya Mandiri", where the results obtained that the success of the hydrotesting process is determined by several factors, namely reliable experts, adequate tools and paying attention to the procedures and standardization used in the hydrotesting process itself [3].
3. Penelitian dengan judul "Analisa Rancangan Pipe Support Pada Sistem Perpipaan High Pressure Vent Berdasarkan Stress Analysis Dengan Pendekatan Caesar II Tegangan Pepipaan High Pressure Vent dengan pendekatan CAESAR II dan dengan batasan Allowable Stress dari ASME B31.3.", diperoleh hasil bahwa pada hasil Stress Hydrotest Load masing masing segmen node tidak ada yang melebihi batasan allowable stress yang diijinkan yaitu 35.000 Psi [5].

Piping System, according to reference [6] Pipes are used to drain fluid (liquid or gaseous substance) from one or several points to one point or several others. The piping system consists of a combination of pipes that have a relatively short total length and are used to drain fluid from one piece of equipment to other equipment operating in a plant. The piping system is equipped with components such as valves, flanges, turns, branching, nozzles, reducers, pedestals, insulation, and others

Kode Standar Pipa, menurut referensi [7] Kode standar desain dikembangkan di negara- negara industri berdasarkan kecelakaan / kegagalan pada sistem pipa di pabrik-pabrik yang tidak dirancang dengan aman, tujuan utama dari kode standar desain adalah keamanan (safety). Kode yang ditunjukkan ASME untuk Perpipaan Tekanan (ASME B31) (termasuk tambahan yang berlaku dan kode kasus), diantaranya; 1) ASME B31.1, "Daya Pemipaan" (ASME B31.1), 2) ASME B31.3, "Proses Perpipaan" (ASME B31.3), 3) ASME B31.9, "Perpipaan Layanan Gedung" (ASME B31.9).

Pipe Standard Code, according to reference [7] The design standard code is developed in industrialized countries based on accidents / failures in pipeline systems in factories that are not designed safely, the main purpose of the design standard code is safety. ASME-indicated codes for Pressure Piping (ASME B31) (including applicable add-ons and case codes), including; 1) ASME B31.1, "Piping Power" (ASME B31.1), 2) ASME B31.3, "Piping Process" (ASME B31.3), 3) ASME B31.9, "Building Service Piping" (ASME B31.9).

There are several standard codes from this B31 committee that are often used as a reference in Indonesia according to the needs of the industrial field, namely; 1) ASME/ANSI B31.1 for piping systems in the power generation industry, 2.) ASME/ANSI B31.3 for piping systems in the process and petrochemical industries, 3) ASME/ANSI B31.4 for oil and other liquid transport pipelines, 4) ASME/ANSI B31.5 for cooling piping systems, 5) ASME/ANSI B31.8 for gas transport pipelines [8][9].

The purpose of this study was emphasized on the third test step, namely the Hydrostatic test, where in the first step preparations were carried out for repairs by welding A106 Gr.B Carbon Steel pipes, which were then continued with VT and PT tests on the weld results. The purpose of this study is to obtain the results of the analysis of Hydrostatic test conditions on the A106 Gr.B Carbon Steel Pipe Welding connection to the applied pressure behavior. With reference to the ASME B13.1 standard. This study also does not discuss the occurrence of corrosion, the welding process in detail is shown in the PQR and WPS that have been made and does not discuss the visual testing process and the Dye penetrant test in detail, but rather conveyed the overall pipe repair procedure

2. Research Methods

The research method used is an experimental study using the Welding Repair Method on the construction of carbon steel pipes (shown in figure 1). This study focused on analyzing pressure changes in welded joints of A106 Gr.B Carbon Steel pipe procedures and conducting research in collaboration with PT. XXX which is a company engaged in fabrication and testing, oil drilling in East Java, adapted to ASME IX

Standard, ASME B31.3. Research materials of U Tube Seal Deck shaped pipe with ASTM / ASME A106 / SA106 Seamless ASTM A106 Class B or ASTM A106 (ASME S / A106) standards, pipe utilization for transportation, main products of steel / steel grade (GR. B), specifications with a diameter of 750 mm with a thickness: 0.8-12 mm Length according to the dimensional image below [8]. The research material is in the form of carbon steel pipe A106 GR. B that has undergone damage and corrosion, this material is used as the main object of research accompanied by accompanying processes that are adapted to ASTM and ASME standards, in terms of the fabrication process which includes the process of cleaning materials, cutting (grinding), welding (SMAW and GTAW) carried out by experts who are certified competence in their fields in accordance with the standards specified in PQR and WPS, For testing is also carried out by certified testing experts. This research is focused on the 9th stage of the Welding Repair method from a total of 10 existing stages. The free variable is in the form of variations in pressure changes (4 rising pressures and 4 falling pressures) (in Psi) which have been planned based on the thickness and length of the pipe joints. Variables are bound to this study hydrotest 28^{O}C test temperature, holding time after pressure change (pressurizing) 10 minutes and 60 minutes for (depressurizing), and focused on the test results in the form of VT, RT, UT, PT, and hydrotest welded joints on the pipe totaling 4 connections. For welding parameters are adjusted with a predetermined PQR and WPS (WPS/CS/EM/ASME/WPxxx).

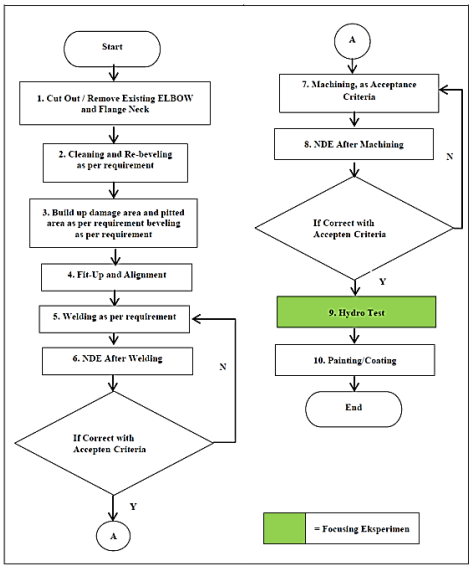


Fig. 1 Hydrotest research flow diagram with Welding Repair method

Table 1 Composition of A106 GR.B Carbon Steel pipes.

ELEMEN	Komposisi, %
	ASTM A106 Gr.B
C max	0.30
Mn	0.29-1.06
P, max	0.04
S, max	0.04
dan, Min	0.10
cr, maxB	0.40
dengan, maxB	0.40
Mo, maxB	0.15
Ni, maxB	0.40
V, maxB	0.08

	ASTM A106 Gr.B
Y. S. Min, psi [Mpa]	35 000 [240]
T. S., Min, psi [Mpa]	60 000 [415]

ASTM A106 G.B	
L	T
22	N2

The Welding Repair is carried out through several stages, including:

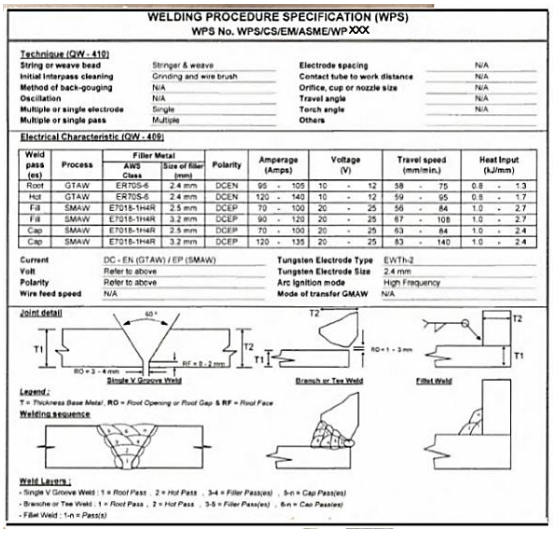
Stage 1. Preparation of the cutter or remove of the existing 90° elbow and neck Flange, cutting or removing the existing 90° elbow will be replaced, and cutting or removing the flange neck joint on the elbow 90°. The accuracy of the cutting area needs to be considered in order to minimize excessive damage to adjacent locations, the flange neck (A106 Gr.B Carbon Steel pipe) will be reattached to the new elbow 90°.

Fig. 2 A106 Gr. B Carbon Steel Pipe (U Tube Seal Deck shaped)

Stage 2. Cleaning and preparing the bevel as needed, the cleaning action will be done by removing rust and painting all elbows 45° (2 pieces) as well as flanges & necks of A106 Gr. B Carbon Steel Pipe

Fig. 3 A106 Gr. B Carbon Steel Pipe (U Tube Seal Deck shaped) cleaned of paint layer and cut [7]

Re-create the bevel at the 45° elbow and neck of the A106 Gr. B Carbon Steel Pipe as per WPS approved (WPS/CS/EM/ASME/WPxxx).



WELDING PROCEDURE SPECIFICATION (WPS)
WPS No. WPS/CS/EM/ASME/WP XXX

Technique (QW - 410)

String or weave bead	Stringer & weave	Electrode spacing	N/A
Initial Interpass cleaning	Grinding and wire brush	Contact tube to work distance	N/A
Method of back-gouging	N/A	Orifice, cup or nozzle size	N/A
Oscillation	N/A	Travel angle	N/A
Multiple or single electrode	Single	Torch angle	N/A
Multiple or single pass	Multiple	Others	

Electrical Characteristic (QW - 409)

Weld pass (es)	Process	Filler Metal AWS Class	Filler Metal Size of filler (mm)	Polarity	Amperage (Amps)	Voltage (V)	Travel speed (mm/min.)	Heat Input (kJ/mm)
Root	GTAW	ER70S-6	2.4 mm	DCEN	95 - 105	10 - 12	58 - 75	0.8 - 1.3
Hot	GTAW	ER70S-6	2.4 mm	DCEN	120 - 140	10 - 12	59 - 95	0.8 - 1.7
Fill	SMAW	E7018-1H4R	2.5 mm	DCEP	70 - 100	20 - 25	56 - 84	1.0 - 2.7
Fill	SMAW	E7018-1H4R	3.2 mm	DCEP	90 - 120	20 - 25	67 - 108	1.0 - 2.7
Cap	SMAW	E7018-1H4R	2.5 mm	DCEP	70 - 100	20 - 25	63 - 84	1.0 - 2.4
Cap	SMAW	E7018-1H4R	3.2 mm	DCEP	120 - 135	20 - 25	83 - 140	1.0 - 2.4

Current	DC - EN (GTAW) / EP (SMAW)	Tungsten Electrode Type	EWTh-2
Volt	Refer to above	Tungsten Electrode Size	2.4 mm
Polarity	Refer to above	Arc Ignition mode	High Frequency
Wire feed speed	N/A	Mode of transfer GMAW	N/A

Joint detail

Single V Groove Weld | Branch or Tee Weld | Fillet Weld

Legend :
T = Thickness (Base Metal), RO = Root Opening or Root Gap & RF = Root Face

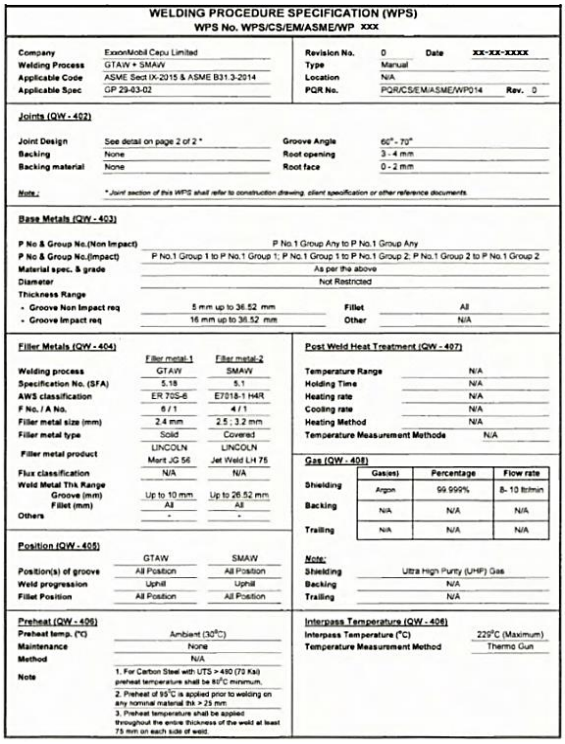
Welding sequence

Weld Layers :
- Single V Groove Weld : 1 = Root Pass , 2 = Hot Pass , 3-4 = Filler Pass(es) , 5-n = Cap Pass(es)
- Branche or Tee Weld : 1 = Root Pass , 2 = Hot Pass , 3-5 = Filler Pass(es) , 6-n = Cap Pass(es)
- Fillet Weld : 1-n = Pass(s)

Fig. 4 WPS Footage of A106 Gr.B Carbon Steel Pipe.

Stage 3. The preparation repairs the damage area and the perforated area as needed, repairing by welding to the surface of the damaged flange thickened by welding for the machining process. Fixing by welding to the surface mount of the flange connecting ladder or the flange plateau.

Stage 4. Equipping and aligning, adjusting to the original image that has been attached to the existing WPS (WPS/CS/EM/ASME/WPxxx), adjusting the new 90° Elbow to the existing 45° elbow, must be aligned accurately.



WELDING PROCEDURE SPECIFICATION (WPS)
WPS No. WPS/CS/EM/ASME/WP XXX

Company	ExxonMobil Cepu Limited	Revision No.	0 Date XX-XX-XXXX
Welding Process	GTAW + SMAW	Type	Manual
Applicable Code	ASME Sect IX-2015 & ASME B31.3-2014	Location	N/A
Applicable Spec	GP 29-93-02	PQR No.	PQR/CS/EM/ASME/WP014 Rev. 0

Joints (QW - 402)

Joint Design	See detail on page 2 of 2 *	Groove Angle	60° - 70°
Backing	None	Root opening	3 - 4 mm
Backing material	None	Root face	0 - 2 mm

Note : * Joint section of this WPS shall refer to construction drawing, client specification or other reference documents.

Base Metals (QW - 403)

P No & Group No.(Non Impact)	P No.1 Group Any to P No.1 Group Any		
P No & Group No.(Impact)	P No.1 Group 1 to P No.1 Group 1; P No.1 Group 1 to P No.1 Group 2; P No.1 Group 2 to P No.1 Group 2		
Material spec. & grade	As per the above		
Diameter	Not Restricted		
Thickness Range			
- Groove Non Impact req	5 mm up to 36.52 mm	Fillet	All
- Groove Impact req	16 mm up to 36.52 mm	Other	N/A

Filler Metals (QW - 404)

	Filler metal-1	Filler metal-2
Welding process	GTAW	SMAW
Specification No. (SFA)	5.18	5.1
AWS classification	ER 70S-6	E7018-1 H4R
F No. / A No.	6 / 1	4 / 1
Filler metal size (mm)	2.4 mm	2.5 ; 3.2 mm
Filler metal type	Solid	Covered
Filler metal product	LINCOLN Mont JG 56	LINCOLN Jet Weld LH 75
Flux classification	N/A	N/A
Weld Metal Thk Range Groove (mm)	Up to 10 mm	Up to 26.52 mm
Weld Metal Thk Range Fillet (mm)	All	All
Others	-	-

Post Weld Heat Treatment (QW - 407)

Temperature Range	N/A
Holding Time	N/A
Heating rate	N/A
Cooling rate	N/A
Heating Method	N/A
Temperature Measurement Methode	N/A

Gas (QW - 408)

	Gas(es)	Percentage	Flow rate
Shielding	Argon	99.999%	8- 10 ltr/min
Backing	N/A	N/A	N/A
Trailing	N/A	N/A	N/A

Note:
Shielding: Ultra High Purity (UHP) Gas
Backing: N/A
Trailing: N/A

Position (QW - 405)

	GTAW	SMAW
Position(s) of groove	All Position	All Position
Weld progression	Uphill	Uphill
Fillet Position	All Position	All Position

Preheat (QW - 406)

Preheat temp. (°C)	Ambient (30°C)
Maintenance	None
Method	N/A
Note	1. For Carbon Steel with UTS > 490 (70 Ksi) preheat temperature shall be 80°C minimum. 2. Preheat of 95°C is applied prior to welding on any nominal material thk > 25 mm. 3. Preheat temperature shall be applied throughout the entire thickness of the weld at least 75 mm on each side of weld.

Interpass Temperature (QW - 406)

Interpass Temperature (°C)	229°C (Maximum)
Temperature Measurement Method	Thermo Gun

Fig. 5 WPS A106 Gr.B Carbon Steel Pipe. [4]

Attach the neck of the existing A106 Gr.B Carbon Steel Pipe to the new Elbow 90° as per the original drawing and the existing WPS (WPS/CS/EM/ASME/WPxxx) [6].

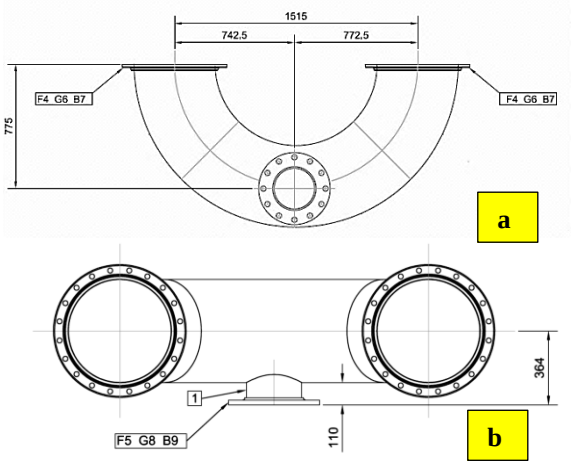


Fig. 6 Dimensions and Material of A106 GR.B Carbon Steel Pipe (U Tube Seal Deck shaped) a. Upper cross section, b front cross section [6]

Stage 5. Welding as needed, performing new welding at a 45° elbow-like joint to a 90° elbow, also welding the flange neck section of the A106 GR.B carbon steel pipe to elbow 90° refers to WPS, and approved image [4].

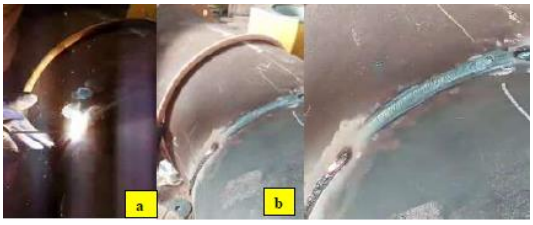


Fig. 7 a. SMAW Welding Process and b. SMAW weld results on A106 Gr.B Carbon Steel Pipe

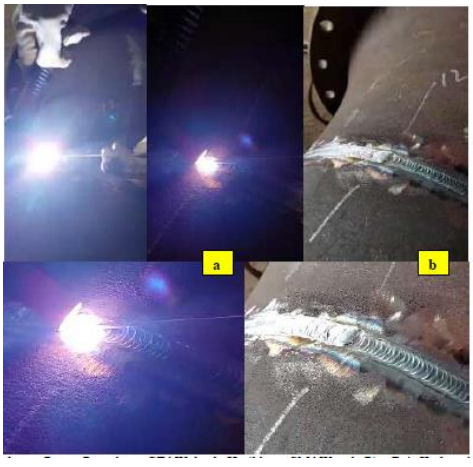


Fig. 8 a. GTAW Welding Process and b. GTAW weld results on A106 Gr.B Carbon Steel Pipe

Stage 6. NDT Testing After Welding, by applying RT (Radiography Test) to welded joints and closed with UT (Ultrasonic Test) to ensure the connection on the flange neck of A106 GR.B carbon steel pipe is free from discontinuities, without cracks, without tearing.

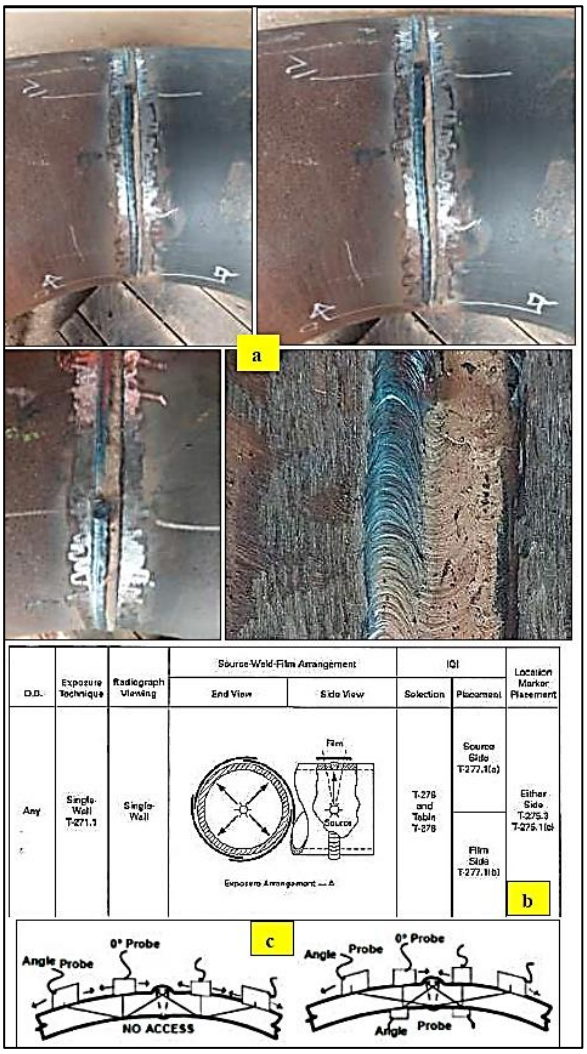


Fig. 9 a. A106 GR.B Carbon Steel Pipe Welds to be RT and UT tested in accordance with WPS, b. Radiographic Test Procedure for Piping Process Work refers to ASME B31.3, c. Ultrasonic Test Procedure for Piping Process Work refers to ASME B31.3 2016 [3].

Stage 7. Welded joint machining process, in order for the criteria to be accepted, The machining process aims to create a new repaired flange, in accordance with the ASME standard for Flat Face Flange (ASME B16.5). using Line Boring Lathes as needed to minimize material movement

Stage 8. NDE testing after machining, by applying PT (Penetrant Test) to ensure the flange is free from any discontinuities, cracks, tears after the machining process.

Fig. 10. Penetrant Test Process and b. ASME/ANSI B31.3 Procedure Penetrant Test Results [3]

Stage 9. Hydro test, by applying hydro testing to ensure flanges and welded joints are free from leakage, in accordance with the hydro testing scheme with pressure kPa./Psi.

Fig.11 Hydrotest test and measuring equipment (a.Barton chart recorder, 0 – 1500 Psi, b.Hydrotest Pipe)

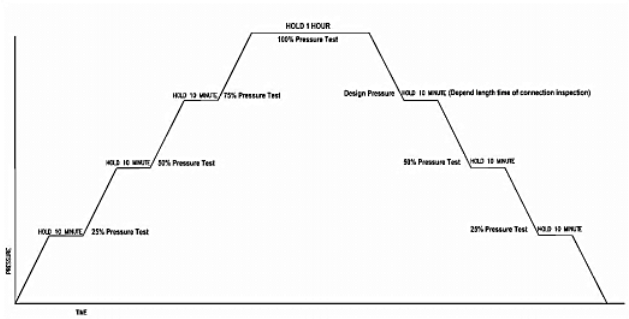


Fig.12 Hydrotest Stages with Pressure and depressure, accompanied by holding Time [11]

The steps shown in the figure above can be described as follows [11]:

1. Hydrotest is confirmed after all NDE requirements have been completed and approved.

2. Hydrotest will be carried out against the pipe spool.

3. Vents and drains that are part of the design should be presented in isometrics. After and during that Hydrotest, this valve must be installed and remain in the open position.

4. Additional vent and drain temporarily required in Hydrotest should be presented on the test package.

5. The vent must be placed in the highest position of the pipeline system to remove air bubbles that may arise at the time of water filling.

6. The drain should be placed at the lowest position of the pipeline system to remove the remaining liquid that is still there after the completion of the Hydrotest.

7. Inspection should be carried out on all joints and equipment contained in the pipeline system.

8. After reaching the hydrostatic testing pressure with a holding time of 10 minutes per pressure increase (pressurizing), and left for a while (60 minutes) to detect any leakage then continued pressure drop (depressurizing) until it is equal to the design pressure.

9. After the test is completed, the water is discharged naturally but with a gradual decrease in pressure as well as 3 (three) times.

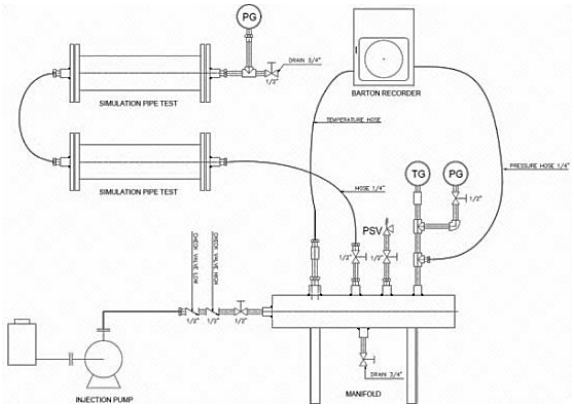


Fig. 13 Hydrotest Scheme [12]

Stage 10. Painting/Coating, Painting applied to welded joints and all affected areas refers to the A/C coating system in red. See Approved painting standards and procedures as follows: a) Zinc Rich Epoxy (manufacturing color standard) 100 μm, b) Epoxy Mastic (manufacturing color standard) 200 μm, c) High Build Epoxy (manufacturing color standard) 200 μm, 4. Urethan (Red) 60 μm.

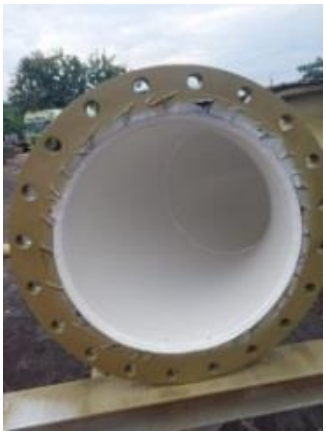


Fig. 14 Coating/coating of A106 GR.B Carbon Steel Pipe (in the form of U Tube Seal Deck)

3. Results and Discussion

After going through the NDE PT (penetran test) testing procedure, hydrotest is carried out with a change in pressure. The following is the data on changes in the Hydro test of A106 GR.B Carbon Steel material, including;

Table 2 Hydrotest Test Results Data

Pressure/ Depressure	Time (PM/ AM)	Hold Time	Pressure Gauge	Temperature	Result
		minute	PG.2 CS	Water °C	Visual Inspection
Pressure 1	14.07	0	0	28°C	No Leaking
Pressure 2	14.17	10	235	28°C	No Leaking
Pressure 3	14.27	10	430	28°C	No Leaking and No Deformation
Pressure 4	14.37	10	685	28°C	No Leaking and No Deformation
Max Pressure	14.47	10	910	28°C	No Leaking and No Deformation
Realese 100%	15.47	60	915	28°C	No Leaking and No Deformation
Realese 75%	15.57	10	690	28°C	No Leaking and No Deformation
Realese 50%	16.07	10	435	28°C	No Leaking and No Deformation
Realese 25%	16.17	10	235	28°C	No Leaking
Realese 0%	16.17	0	0	28°C	No Leaking

Table 2 above is described in the following discussion;

a. Initial pressure of 0 Psi in the hydrotest process of A106 GRB carbon steel pipe.

Fig. 15 Pressure 0 Psi and Chart Recorder 0 Psi

Tahap pertama melakukan *Pressurizing* pada *hydrotest* di mulai dari 0 psi tekanan pada jarum *pressure gauge* harus menunjuk di angka 0 dan pada recorder barton menunjuk di titik 0,di titik 0 ini menunjukkan akan di lakukan proses tekanan pipa yang berkelanjutan pada proses *hydrotest* pipa baja karbon A106 GR.B.

b. Initial pressure of 240 Psi in the hydrotest process of A106 GR carbon steel pipe. B

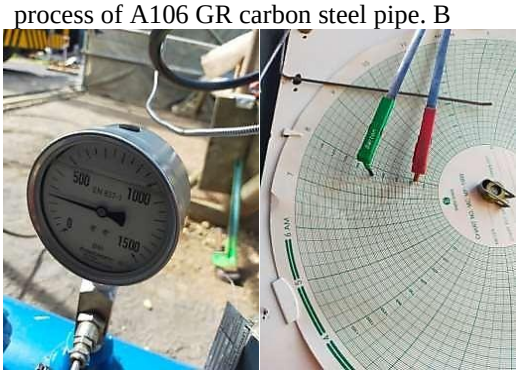


Fig. 16 *Pressure* 240 Psi *Chart Recorder Pressure* 240 Psi

The second stage is to do an inject at a pressure of 240 Psi the pressure on the pressure gauge needle must point at 240 Psi and at the barton recorder pointing at the point of 240 Psi at this stage the process of increasing the pressure on the pipe is allowed to stand for 10 minutes to find out this process the pipe has a leak or not if it does not have a pipe leak is increased again at the next pressure in the hydrotest process of the A106 GR.B carbon steel pipe.

c. Initial pressure of 435 Psi in the hydrotest process of carbon steel pipe A106 GR.B.

Fig. 17 Pressure 435 Psi Chart Recorder Pressure 435 Psi

The third stage is the increase in pressure from 240 Psi to 435 Psi if the pipe does not have a leak in the inject at a pressure of 435 psi the pressure on the pressure gauge needle must point at 435 Psi and on the barton recorder point at the point 435 Psi at this stage the process of raising the pressure on the pipe is allowed to stand for 10 minutes to find out this process the pipe has a leak or not if it does not have a pipe leak is raised again on further pressure on the hydrotest process of carbon steel pipe A106 GR.B.

d. Initial pressure of 690 Psi in the hydrotest process of carbon steel pipe A106 GR. B

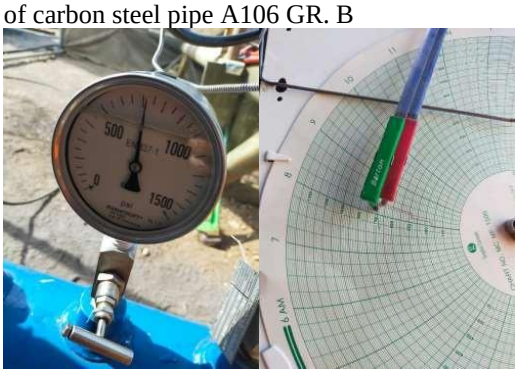


Fig. 18 Pressure 690 Psi Chart Recorder Pressure 690 Psi

The fourth stage is the increase in pressure from 435 Psi to 690 Psi if the pipe does not have a leak in the inject at a pressure of 690 Psi the pressure on the pressure gauge needle must point at 690 Psi and on the barton recorder point at the point of 690 Psi at this stage the process of increasing the pressure on the pipe is allowed to stand for 10 minutes to find out this process the pipe has a leak or not if it does not have a pipe leak is raised again on further pressure on the hydrotest process of carbon steel pipe A106 GR.B.

e. Initial pressure 915 Psi in the hydrotest process of carbon steel pipe A106 GR.B.

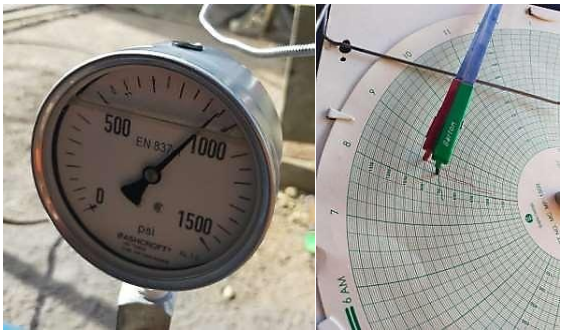


Fig. 19 *Pressure* 915 Psi *Chart Recorder Pressure* 915 Psi

The fifth stage is the last increase in pressure from 690 to 915 if the pipe does not have a leak in the inject at a pressure of 915 Psi the pressure on the pressure gauge needle must point at 915 Psi and on the barton recorder point at the point 915 Psi at this stage the pressure increase process on the pipe is allowed to stand for 1 hour to find out this process the pipe has a leak or not if it does not have a leak then the pressure drop process (Depressurizing) on the hydrotest process of carbon steel pipe A106 GR.B. penurunan tekanan (*Depressurizing*) pada proses *hydrotest* pipa baja karbon A106 GR.B.

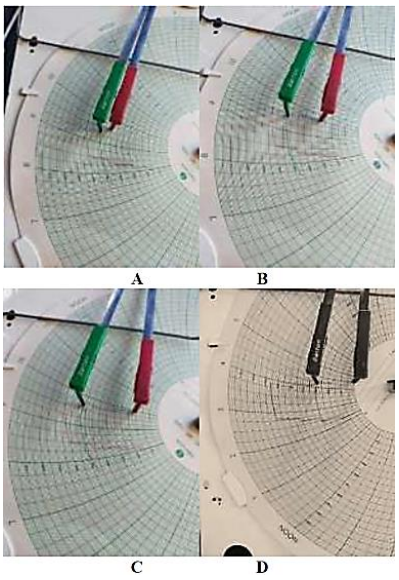


Fig. 20 Proses *depressure* A. *Release* 75% *B. Release* 50 %, *C. Release* 25 %, *D. Release* 0%

The sixth stage is the Release of 75% decrease in pressure from 915 Psi to 690 Psi after passing the stage of being let stand for 60 minutes in the pressure drop process must also wait 10 minutes in this process, if the pipe does not experience a leakage of the Carbon Steel A106 Gr.B hydrotest process.

The seventh stage is the Release of 50 % decrease in pressure from 690 Psi to 435 Psi in the pressure drop process waiting 10 minutes in this process, if the pipe does not leak the Carbon Steel A106 GR.B hydrotest process.

The eighth stage is the Release of 25% decrease in pressure from 435 Psi to 240 Psi in the pressure drop process waiting 10 minutes in this process, if the pipe does not leak the Carbon Stell A106 GR.B hydrotest process.

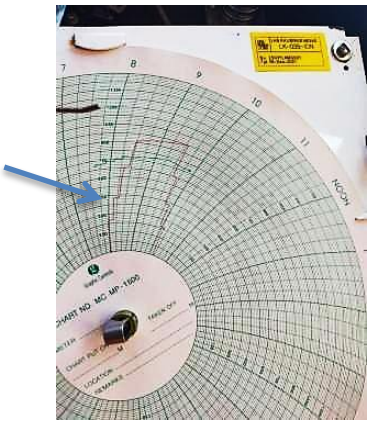


Fig. 21 Hydrotest Results of A106 GR carbon steel pipe. B (shown on the arrow) hydrotest carbon steel pipe A106 GR.B.

The ninth stage is the Release 0% decrease in pressure from 240 Psi to 0 Psi in the reduction process and the last stage of the hydrotest process of the A106 GR.B carbon steel pipe, the barton chart results are shown in figure 22.

The results of the hydrotest process of carbon steel pipe A106 GR.B can be read through the barton chart decreased or increased the pattern of ink lines due to temperature changes at the time of conducting the test and on the A106 GR.B carbon steel pipe has no effect at all on cold or hot temperatures.

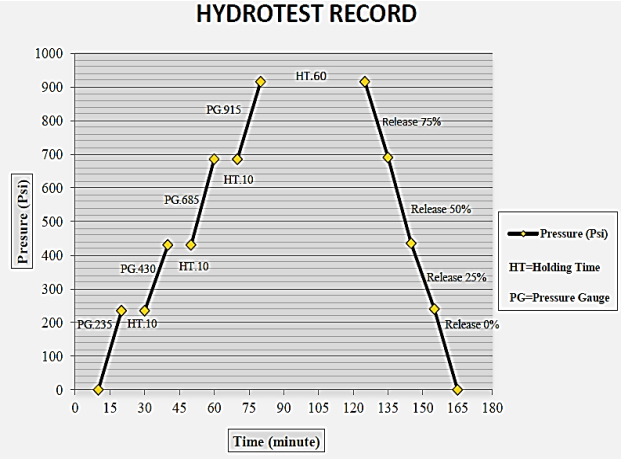


Fig. 22 Hydrotest Results Graph of A106 GR.B carbon steel pipe.

From figure 23 above, the results can be obtained that the pressure change is divided into two stages of pressure change, the first press is increased by 4

different pressures (pressuring) in each pressure change is held (holding Time) and obtained results without leakage in each welded joint that has been carried out with the highest pressure of 915 Psi, then pressure detention is carried out for 60 minutes and also obtained the results of the welded connection do not leak, and already according to the admission criteria. While the second stage with pressure reduction (depressurizing) with 4 pressure variations or called realese where realesae 100% at a pressure of 915 Psi then Realease 75% pressure 690 Psi without any time hold obtained results without leakage the next gradually decreased successively 435 Psi, 240 Psi. In the hydrotest test there was no deformation, no deformation and leakage in the welded joint layer of carbon steel pipe A106 Gr.B. In the hydrostatic test, there were no deformations, no deformations and leaks in the welded layer of the A106 Gr.B. carbon steel pipe. B of environmental corrosion needs to be painted / coating process or if it occurs corrosion damage, repairs can be made using the Welding Repair method.

4. Conclusions

Analysis of pressure changes in the welded joints of A106 GR.B carbon steel pipes that have been welded and tested with NDE PT and checked by Visual Inspection, as well as the results of hydrotest tests obtained the following conclusions: that the fabrication process on the A106 GR.B carbon steel pipe has met the acceptance criteria according to standards. In the results of the NDE visual inspection and penetrant test (PT) there are no defects or there is a red color on the weld surface on the connection of the A106 GR.B carbon steel pipe, it is concluded that the welding process is carried out well with good results and also on the criteria for achieving visual NDE testing, the inspection and penetrant welding tests can be well received. Meanwhile, the Hydrostatic test results can be obtained that the pressure value varies and has a pressure holding duration of 10 minutes expecting to get the highest value for the resistance of the A106 GR.B carbon steel pipe. Then in the last test, the highest pressure of 100% (915 Psi) with a length of time of 1 hour is a good peak point for testing. In the hydrostatic test, there was no deformation, no deformation and leakage in the welding layer of the A106 GR.B. carbon steel pipe, furthermore, to reduce the corrosion rate of the A106 GR.B carbon steel pipe to seawater by fabricating (repair welding) the A106 GR.B carbon steel pipe and applying a layer (painting / coating).

Reference

[1] ASME BPVC. “Power Piping (ASME B31.1-2013) ASME B31.3-2012”. 2012. 2012

[2] ASME BPVC. “Pressure Piping Code, including applicable addenda Andcodecases ASME B31.1-2013”. 2013

[3] ASME.”ASME B31.3 Process Piping Standart”. *New York: American Society of Mechanical Engineers*. 2016

[4] ASME BPVC. “Building Services Piping (ASME B31.9-2014)”. 2014

[5] AWS D1.1. “Structural Standard” . 2015

[6] Abdul Aziz dan Muchamad Oktaviandri. “Pengaruh Udara Yang Terkurung Di Chart Recorder Pada Proses Hydrotesting Test PT. Mulia Jaya Mandiri”, *Jurnal Teknik Mesin*: Vol. 09, No. 1, Februari 2020

[7] CPDS 03-19-02 Rev 3. “Upstream Piping Fabrication, Erection, Inspection, Testing, and Cleaning Cepu Project Design Specification”CPDS 29-03-06 Rev 0. “Onshore Structural Welding and Inspection”.

[8] CPDS 04-09-04 Rev 0. “Specification for Structural Steel Fabrication”.

[9] Amri Moh. Syaiful, dkk. “Analisis Multiple Repair Pada Material Baja Karbon SA 333 Grade 6 dengan Proses GTAW Terhadap Kekerasan Ketangguhan, dan Struktur Mikro”. *Jurnal INOVTEK POLBENG*, Vol. 12, No. 1, Juni 2022

[10] Pridyatam Parada Anugerah. “Analisa Rancangan Pipe Support Pada Sistem Perpipaan High Pressure Vent Berdasarkan Stress Analysis Dengan Pendekatan Caesar II Tegangan Pepipaan High Pressure Vent dengan pendekatan CAESAR II dan dengan batasan Allowable Stress dari ASME B31.3”. *Jurnal Teknik POMITS* Vol. 3, No. 2, 2014

[11] SLAC, “Pressure Systems, Pressure Test Procedures. Hydrostatic Test”. SLAC National Accelerator Laboratory Environment, Safety & Health Division, Product ID: 613,| Revision ID: 2375, Date published: 26 October 2021, Date effective: 26 October 2021

[12] Terasen Pipelines. “Main Line Hydrostatic Test Procedure, MP4121, Revision 2”. July 1999, Terasen Pipelines (Trans Mountain) Inc. Engineering Standars And Practice

[13] Waspodo. “Analisa *Head Loss* Sistem Jaringan pipa pada sambungan pipa kombinasi diameter berbeda”. *Universitas Muhammadiyah Pontianak*. 2017