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Manufacturing Process of 226-Liters Thinner Storage Tank

Akmal Lukmanulhakim 1[a*], Deri Teguh Santoso 2[a]

[a]*Department of Mechanical Engineering, Faculty of Engineering, University of Singaperbangsa Karawang, Jl. HS. Ronggo Waluyo Telukjambe Timur, Karawang 41361, Indonesia*
**Corresponding author email: 2010631150022@student.unsika.ac.id*

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ABSTRACT

This research focuses on the manufacturing process of a thinner storage tank with a capacity of 226 liters. The objective is to identify the materials and process stages involved in producing the tank. The study employs a direct research and development methodology to explore this topic. For the tank's body, SUS 403 stainless steel is selected for its excellent corrosion resistance, while ST45 steel is chosen for the frame due to its high load-bearing capacity. The manufacturing process includes material selection, cutting, rolling, welding, finishing, and quality control. In the welding phase, Gas Tungsten Arc Welding (GTAW) is utilized with ER308L filler, applying a current of 70 amperes for the tank body and 100 amperes for the tank head. For the frame, Shielded Metal Arc Welding (SMAW) is employed using RD260 2.6mm electrodes at a current of 90 amperes. The study aims to provide comprehensive insights into the selection and application of materials and processes for efficient tank.

Keywords: Manufacturing Process, Welding, Stainless Steel,Thinner storage tank

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1. Introduction

The manufacturing industry plays an important role in the global and local economy, providing the goods and services needed by society. The history of industrial development shows that since the Industrial Revolution in the 18th century, there have been significant changes in the way goods are produced [1]. Modern industry relies heavily on automation technology, robotics, and integrated information systems to optimize the production process.

In the production process, of course, there are stages that will be passed by a raw material that has not been shaped or in the sense that it has not been processed to become finished goods or products to be marketed. The stage starts from the selection of materials or materials to the finishing process to quality control [2].

The industrial production process can be divided into several types based on the methods and techniques used, such as mass production, batch production, and unit production. Mass production, for example, allows the manufacture of a large number of products at a low cost per unit, but requires a large initial investment [3]. Batch production allows flexibility in manufacturing different types of products, but may be less efficient than mass production. Piece production is the activity of making products in small and limited quantities or when there are orders only. For example, PT X where the author conducted practical work carried out the concept of unit or limited production [4].

PT X is a manufacturing company oriented towards manufacturing, fabrication and machining services. Many products are carried out by this company including the manufacture of cold storage piping systems, cradle rack rigging gas cylinders, steel strollers, and thinner storage tanks. Thinner is a chemical solvent: as a cleaning fluid (hard stains), paint & glue remover, epoxy resin solvent, odor remover, industrial solvents (Glue, printer ink, etc.). In the preparation of this practical work report, the authors took the problem of the manufacturing process of making a thinner storage tank with a capacity of 226 liters [5]. Which consists of several processes such as cutting, rolling, drilling, welding, and finishing.

1.1 Stainless Steel SUS 304

Stainless steel, is a metal alloy that contains iron (Fe), carbon (C), and at least 10.5% chromium (Cr) which gives the material its rust-resistant properties. Stainless steel is often used in a variety of industrial and commercial applications due to its unique combination of strength, corrosion resistance, and attractive aesthetic appearance [6].

The naming "SUS 304" is a standardized naming system used to identify certain types of stainless steel. This naming is primarily used in Japan, while other regions may use different naming conventions such as AISI (American Iron and Steel Institute) or EN (European Norm).

SUS stands for "Steel Use Stainless," which is a common term for stainless steel in Japan, 304 is a numerical code representing a specific type of stainless steel. In this case, 304 indicates stainless steel with a minimum chromium content of 18%, a minimum nickel content of 8%, a maximum carbon content of ≤0.8%, a maximum manganese content of ≤1.0%.

Therefore, SUS 304 is a type of austenitic stainless steel that is well known for its excellent corrosion resistance, formability, weldability, and versatility in various applications[7]. This steel is commonly used in food processing equipment, medical devices, architectural components, automotive parts, and more.

1.2 ST45 Steel

Steel or carbon steel is a type of steel that consists primarily of iron (Fe) and carbon (C), with little or no other alloying elements. Carbon steels are differentiated by their carbon content, which affects their mechanical properties and applications [8] .

The "ST45" naming is a standardized naming system used to identify certain types of carbon steel in Germany and other European countries. It is based on the DIN (Deutsches Institut für Normung) standard, which provides a comprehensive classification system for various materials. St stands for "Stahl," which is the German word for "steel." 45 is a numerical code this represents a specific type of carbon steel. In this case, 45 indicates steel with a carbon content of 0.45%, manganese ≤0.60%, phosphorus ≤0.040%, sulfur ≤0.050%.

Therefore, St45 is a type of carbon steel with medium strength and ductility, making it suitable for various structural applications, such as construction, machine components, frames, and others.

1.3 Welding

Welding is a process of joining two or more materials, usually metals, using heat energy until the material to be joined melts (melted) and then fused, by applying pressure or not, and by providing additional materials (consumable) or not.

Welding according to the American Welding Society (AWS) is the process of joining two metals by melting or without melting one or both of the metals [9]. There are many types of welding including SMAW (Shielded Metal Arc Welding) and GTAW (Gas Tungsten Arc Welding).

1.4 SMAW (Shielded Metal Arc Welding)

SMAW welding, which stands for Shielded Metal Arc Welding, also known as electric welding or stick welding, is one of the most commonly used types of electric welding [10]. SMAW welding has several parts that will be shown in the following figure.

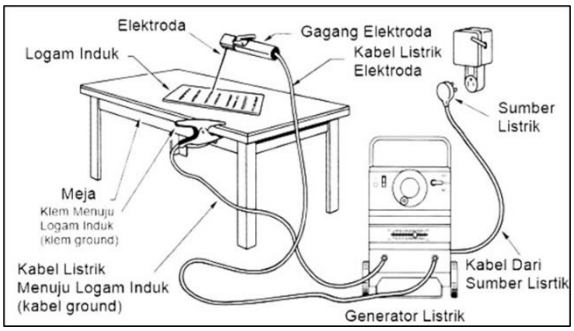

Figure 1. SMAW Welding Parts Section

1.5 GTAW (Gas Tungsten Arc Welding)

GTAW (Gas Tungsten Arc Welding) welding, also known as TIG (Tungsten Inert Gas) welding, is a welding process that uses a non-consumable tungsten electrode and shielding gas to generate heat and protect the weld from contamination. This weld just like any other weld has several parts, as shown below[11].

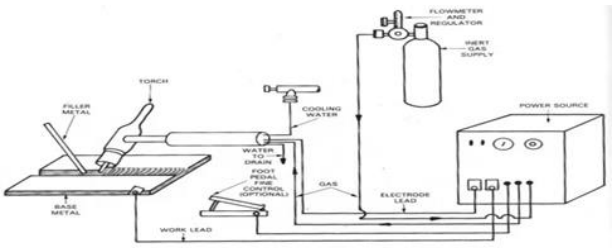

Figure 2. GTAW Welding Parts Section

2. Methodology of Research

The method used in this research is research and development. Da ta is taken through direct observation and through reference books both from companies and websites and journals related to the report material. The data obtained was analyzed using descriptive analysis. This research was conducted for one month starting from December 2023 to January 2024. This research was conducted at Perumnas Bumi Telukjambe Timur Blok T 20, West Karawang.

2.1. Tools and Material

The following are the tools and materials used in this research : Meters, makers, hand grinder, iron roller, drilling machine, welding machine and brush

2.2. Research Flowchart

As the title implies, the tinner storage tank is a closed cylindrical or drum-shaped container which is made of steel that has undergone a production process so that it can accommodate the exact liquid, namely tinner. Basically the client only requested a capacity of 150 liters, but taking into account the safety factor in the pressure section, the manufacturer increased the capacity to 226 liters.ner with a capacity of 226 liters is finished and ready to use.

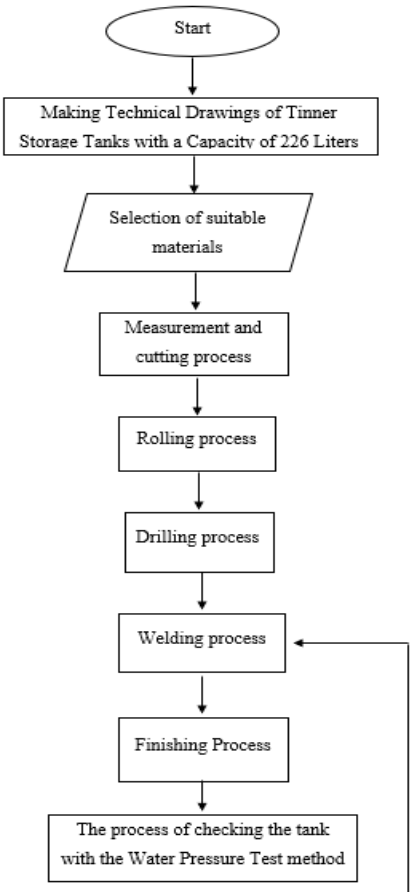

Figure 3. Research Flowchart

The flowchart of the planning and manufacturing process in Figure 5 begins with a literature study. The literature study aims to find and collect references or materials related to the process of making a Thinner Storage Tank with a Capacity of 226 liters. The references collected come from journals, books, and sources from the internet.

The next step is to make a technical drawing of the Tinner Storage Tank with a Capacity of 226 liters. This process aims to design the shape of the Tinner Storage Tank with a Capacity of 226 liters.

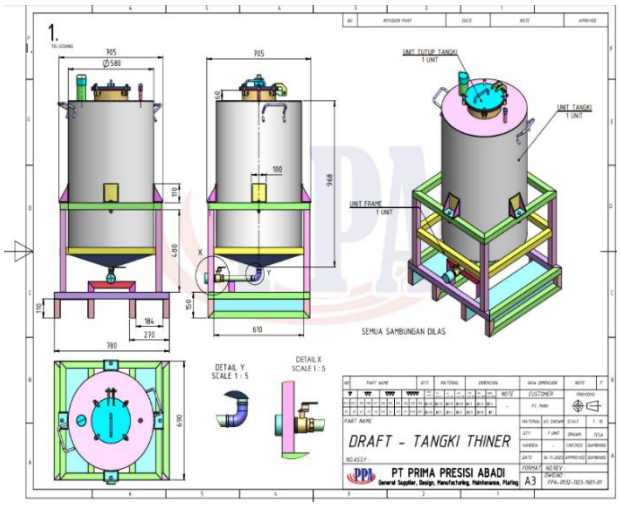

Figure 4. Technical drawing of Thinner Storage Tank with 2 26 Liter Capacity

The next step is the selection of tools and materials. This step aims to find materials that match the criteria of the tool to be made and choose the most suitable material for certain applications in engineering. After completing the selection of tools and materials, the process of measuring and cutting materials will be carried out.

Material cutting is done according to the size specified in the design. If it is not appropriate, the calculation and design of the design will be carried out again. However, if it is in accordance with the calculation and design, the next stage can be carried out, namely the rolling process, drilling process to the welding process. The final stage is testing the tank with the water pressure test method whether it functions according to plan or not. If it is in accordance with the plan, it will continue at the stage of making the final report.

3. Result and Discussion

In the design of Figure 5 illustrates the design of the thinner tank design to be made, outline the design has two parts which are the tank itself and the tank support frame. The tank part fully uses stainless steel material with a thickness of 1.8 mm and the frame part uses fully uses ST45 steel material with a thickness of 1.8 mm too. For the outer diameter of the tank itself is 580 mm and its height is 968 mm. Thus the tank has a total volume of 256 litres. For the frame of the support foot area is 780 mm x 780 mm x 190 mm and for the pole of the support frame is 480 mm, for other details can be understood in the technical drawings above.

3.1 Material Selection

The material chosen is mostly divided into two parts, namely the first part of the tank which uses stainless steel and the frame and ear supporting the tank using st45 steel. Stainless steel is used in the tank because it has several advantages, including,

- Attractive appearance
- Not easy to rust
- Does not react with thinner
- The material is very easy to obtain in the market

In addition, stainless iron which has thinness makes it easy to process it into a slinder shape. While on the frame and ear supporting the tank using ST45 steel due to the following points,

- Its strong nature to support heavy tank parts
- Materials easily found in the market
- The price is fairly inexpensive

3.2 Measurement and Cutting

The material that has been selected is st45 steel for the frame and stainless plate for the main material of the tank. First the material will be measured according to the dimensions in the design plan and after that the cutting is done using hand grinders. This process is carried out in different places because the manufacturer has partners.

3.3 Rolling Process

In the next stage, the stainless steel plate that has been cut according to the specified dimensions enters the rolling process, which aims to form the stainless steel plate into a cylindrical shape, while the st45 steel used for the frame can directly enter the welding process. This process was also carried out outside the place of my practical work for **the same reason.**

3.4 Drilling Process

Before entering the finishing process, the drilling process is carried out, which aims to make bolt holes that function to lock the tinner tank on the frame so that it does not easily change position, here is a picture of the position where the drilled part is.

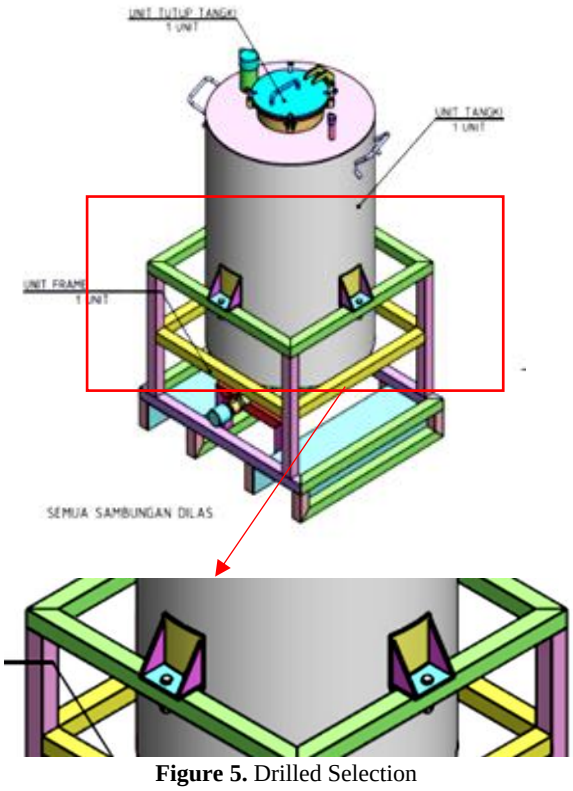

Figure 5. Drilled Selection

3.5 Welding Process

At the welding stage, the welding used is GTAW (Gas Tungsten Arc Weldning) welding, GTAW type welding is used because it sees thin workpieces, so that no damage occurs, GTAW type welding is used to weld the tank section. As for the frame part using SMAW (Shield Metal Arc Welding) welding. in this process requires high accuracy and expertise, so in this process the rest will be explained again in the next sub chapter.

3.6 Finishing

In the finishing process, the weld marks on the tank are cleaned using a special cleaning liquid that is applied using a brush. For the frame itself, it is immediately cleaned and then a painting process is carried out which is useful for coating the material so that it is not easily corroded or damaged. In addition, in the finishing process, inspection or checking of the object being worked on is also carried out by going through several standardizations, if it meets the standards, the product is ready to be sent to consumers, but if it does not meet the standards, the goods will return to the welding process, why return to the welding process because the process carried out in this place is in the form of finished goods and only needs to be welded, so if a defect occurs, it will not be far from the welding process.

Figure 6. Finishing Process

The test carried out in this project is to fill the tank with pressurized water if a leak occurs, it will be re-welded, and if not, the product is ready.

3.7 Water pressure Test

In testing for thinner tanks made at PT, the main purpose is only to find out whether there is a leak or not in the welding connection, while the tank's ability to withstand maximum pressure is not measured in this test. The following are the steps for testing thinner tanks using this method.

- Select one of the tanks that has been completed to the finishing stage to be used as a sample.
- Fill the tank with water as much as 4/10 of the tank volume.
- Close all existing holes and leave one hole to drain the water.
- Put the manometer in place.
- Connect the hose from the water pump to the remaining hole.
- Turn on the pump and run the water.
- If the pressure is about to reach maximum turn off the pump and then discharge the water slowly to avoid water explosion.

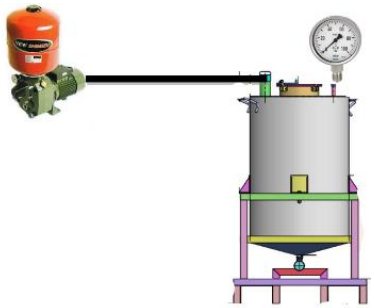

Figure 7. Schematic Illustration Of Water Pressure Test

3.8 Welding Process of Thinner Storage Tank with 226 liters Capacity

The welding process is a fairly crucial process in a production process, so in this sub chapter will explain how the welding process of making thinner storage tanks made at PT X. For the type of welding used, namely GTAW (Gas Tungsten Arc Welding) for tank parts and SMAW (Shield Metal Arc Welding) for frame parts.

- **Welding with GTAW (Gas Tungsten Arc Welding)**

In the process of making a thinner storage tank, GTAW welding is used to weld parts of the tank that are made of stainless and have a thin thickness. The electrodes and fillers used are ER308L as well as the filler.

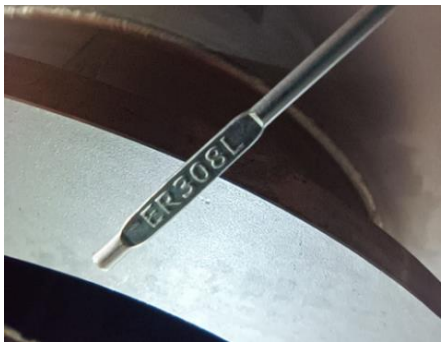

Figure 8. *Filler* ER308L

ER308L wire is a type of filler wire in GTAW welding that has 18% Cr Alloy and 10% Ni The letter “R” in ER indicates welding wire, “3” indicates austenitic stainless steel classification, “08” indicates 8% nickel content, and “L” indicates low carbon content (low carbon).

Referring to the general guidance table above, namely Table 3.4.2.1 for the amperage used, namely 70 amperes for the tank body and 100 amperes at the head / lid of the tank.

The head of the tank requires a larger current because it has a thicker thickness than the tank body, which is 10mm. When the welding process of the tank body including the top and bottom covers is carried out with the tank lying down or 1G position, while when the welding process of the tank head is carried out with a standing position or 2G.

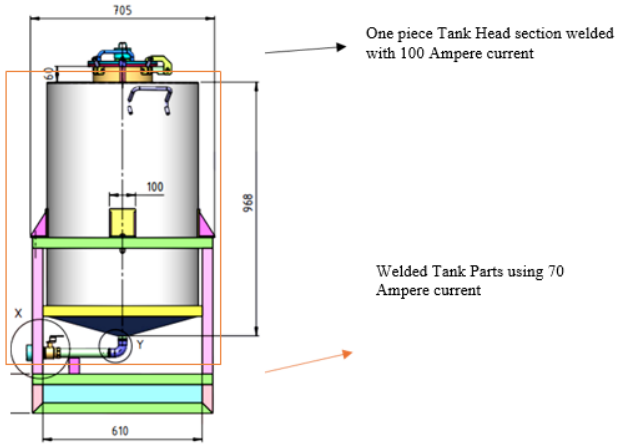

Figure 9. Parts Welded With 100 Ampere And 70 Ampere Current

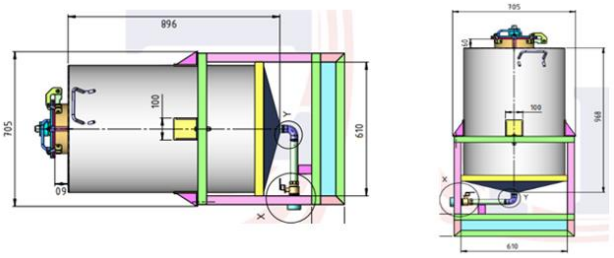

Figure 10. Illustration Of Tank Welding With 1G And 2G Positions

- **Welding with SMAW (Shield Metal Arc Welding)**

In the process of making a thinner storage tank, SMAW welding is used to weld the frame parts, for the electrode used is the RD260 type with a diameter of 2.6mm.

RD260 is used because it has several advantages, which are high strength because the RD wire itself has a large iron composition, which reaches 75%, which with this composition is very suitable for application to steel materials and is used to weld support or retaining structures such as the frame function in this project. In the process of welding the frame part is done in position F or a special position for the elbow. As shown in the picture, all frame elbow joints are welded in 2F and 3F positions, 2F for elbows facing right or left above and 3F for elbows facing sideways to the left or right.

Figure 11. RD260 2.6mm Electrode

The amperage used is 90 amperes, because the Rd wire itself has characteristics that require it to use a slightly larger current than ordinary wire, and the characteristics of the st45 steel material used and its thickness, according to table 3.4.1.1 that a plate that has a thickness of 2mm and an electrode with a diameter of 2.6 mm will require 80-120 Amperes.

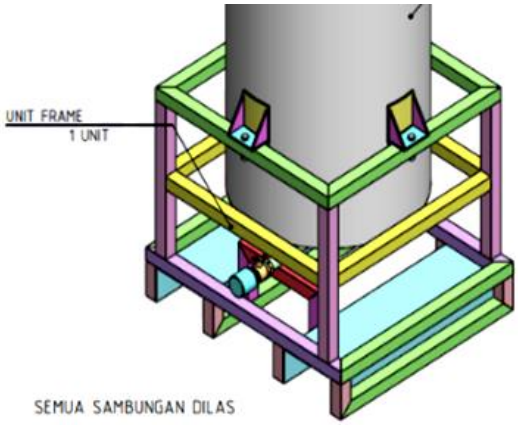

Figure 12. Frame Section Welded F Position

4. Conclusion

Based on the results of the research conducted, The selection of SUS 403 stainless steel material for the tank is appropriate, because stainless steel material is a type of metal that is very good at resisting rust or corrosion. In addition, the selection of St45 steel for the frame is appropriate because of the strong nature of St45 steel to be used as a load-bearing frame.

The stages of the process of making thinner storage with a capacity of 226 liters are starting from material selection, cutting, rolling, welding, finishing, then quality control.

The quality control process in the process of making storage thinner with a capacity of 226 liters uses testing with a water pressure test which is the goal of this process to find out leaks in the welding joints and tests carried out on samples do not leak.

In the welding process, the tank part is welded using GTAW (Gas Tungsten Arc Welding) welding using ER308L type filler with a current of 70 amperes in the tank body and 100 amperes in the tank head. As for the frame using SMAW (Shielded Metal Ars Welding) welding with the electrode used is type RD260 2.6mm with a current of 90 amperes.

5. Acknowledgement

Thank you to PT. X for providing convenience in data retrieval and to all parties who have helped the Author.

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