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Application of FCAW Welding Techniques in Supply Boat Manufacturing at PT Vallianz

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ABSTRACT

FCAW is a semi-automatic welding method that offers advantages in welding speed, weld quality, and flexibility in various welding positions. The process begins with equipment preparation, selecting welding parameters according to the Welding Procedure Specification (WPS) standard, and then carrying out welding using root pass, fill pass, and cap pass techniques. Evaluation of welding results is carried out through visual inspection and non-destructive testing (NDT), such as Magnetic Particle Inspection (MPI) and Ultrasonic Thickness Testing (UT) to ensure the quality and integrity of the joint.

The results show that the FCAW method is highly effective in supply boat fabrication, especially when supported by good work procedures, adequate operator skills, and strict quality control. This research is expected to provide a practical overview and serve as a reference for students and industry in implementing welding technology in the shipping sector.

Keywords: FCAW, welding, supply boat, shipbuilding industry

1.0 INTRODUCTION

Supply boats are a crucial type of vessel in supporting the offshore oil and gas industry. They play a vital role in transporting various logistical needs, such as fuel, equipment, heavy equipment, and materials needed by drilling platforms or large ships at sea (Nasution, 2016). Supply boats enable more effective and efficient operations at sea, given the geographical conditions that make them difficult to reach by land transportation. The process of building a supply boat is a complex engineering project, involving various disciplines and requiring advanced technology. One crucial aspect of supply boat construction is welding techniques. Welding is the process of joining metal materials, particularly steel, which is often used in ship structures (Djunaedi, 2015).

Welding plays a crucial role in providing structural strength, resistance to pressure, and resistance to corrosion caused by exposure to seawater (Suyitno, 2011). However, despite welding being the most widely used method in shipbuilding, it is undeniable that the application of welding techniques in supply boat construction presents its own challenges. Supply boat construction requires careful consideration of many technical factors, including the selection of materials, the appropriate welding technique, and careful quality control of the weld. One of the major challenges faced is ensuring proper welding, as failure to do so can have disastrous consequences, both in terms of ship operational safety and significant repair costs (Purnomo, 2013).

Improper welding techniques can result in welding defects, such as cracks, porosity, or unevenness in the weld joints, which risk weakening the ship's structure. Furthermore, supply boats operate in extreme sea conditions, with high pressures, varying temperatures, and exposure to seawater that can accelerate corrosion of ship materials (AWS, 2020). Therefore, welding quality must be strictly maintained to ensure the ship's longevity and proper function during operations at sea. As an industry engaged in ship construction and ship maintenance, it is important to clearly identify the problems encountered in welding in supply boat manufacturing and suggest appropriate solutions. The implemented solutions will not only improve the quality of the vessel, but will also impact cost efficiency and production time, as well as ensure the safety and sustainability of supply boat operations at sea (DNV-GL, 2019).

With a deeper understanding of these challenges, the supply boat manufacturing industry can develop more effective welding methods and techniques and address various technical issues that arise in the production process. Therefore, this research is crucial in providing a clear picture of how welding can be optimized in supply boat manufacturing and how the latest technologies can be utilized to improve welding quality and performance in the shipbuilding industry.

The purpose of this study is to determine and analyze the challenges faced in applying welding techniques to the manufacture of supply boats, assess the importance of applying appropriate welding techniques in improving the quality of supply boat structures, and identify solutions that can be applied to overcome problems that arise during the welding process.

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2.0 METHOD

The methods used by the author to search for and obtain the data needed in this report are:

a. Observation

Observation is a method where the author directly participates in activities within the work environment. This method allows for direct understanding of the problems observed in the field, thus facilitating report writing.

b. Interview

Interviews are one technique that can be used to collect research data. This method involves asking questions. Interviews were conducted with managers and employees in the work environment where the author conducted the practical work. This method was chosen because the author cannot master everything involved in the practical work. Therefore, to gain additional information while conducting the practical work, the author needs to ask questions and obtain explanations from parties familiar with the problem. The author can ask detailed questions and request clarification on anything related to the material used in compiling this report.

c. Literature Study

This method involves searching for and reading literature related to the topic. This method is used to clarify the first and second methods.

3.0 RESULT

3.1 Tools

The tools used in FCAW welding are:

a. FCAW Welding Machine

Function: Power source to create an electric arc.

Usually uses DC (Direct Current) with DCEP (Direct Current Electrode Positive) polarity. The FCAW machine used was shown in Figure 1 below.

Figure 1: Welding machine

b. Wire Feeder

Function: Automatically and continuously distributes welding wire (flux cored wire) to the welding area.

Integrated or separate from the welding machine depending on the type of tool. The wire feeder used was shown in Figure 2 below.

Figure 2: Wire feeder

c. Flux Cored Wire

Function: A tube-shaped electrode containing flux in the center.

Example specification: AWS A5.20 E71T-1.

There are two types:

- Self-shielded FCAW (FCAW-SS): Does not require shielding gas.
- Gas-shielded FCAW (FCAW-GS): Uses external shielding gas.

d. Shielding Gas (CO_2 gas cylinder)

Function: Protects the welding pool from contamination by surrounding air. Usually CO_2 gas or a mixture of argon + CO_2 is used. The CO_2 gas cylinder used wasshown in Figure 3 below.

Figure 3: CO_2 gas cylinder

e. Welding Torch (FCAW Welding Holder / Gun)

Function: Channels welding wire and protective gas to the welding area. Equipped with :

1. Nozzle: Directs gas to the welding area.
2. Contact Tip: Conducts current to the welding wire.

Nozzle and connect tip were shown in Figure 3 below.

(a) (b)

Figure 3: (a)Nozzle and Contact Tip, (b) Welding Gun

(f) Personal Protective Equipment (PPE)

Function: Protects the operator from sparks, radiation and hazardous gases.

Example:

- Welding helmet
- Heat resistant gloves

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- Fire-resistant apron
- Safety shoes
- Protective glasses
- Mask or respirator (if welding in a confined space)

Personal protective equipment was shown in Figure 4 below.

(a) (b) (c) (d) (e)

Figure 4: (a) Protective helmet, (b) Gloves, (c) Safety shoes (d)safety glasses, (e) Fire resistant aprons, (f) Mask

f. Slag Residue Cleaning Tool
Function: Cleans the remaining slag from welding.
Example tools:

- Chipping hammer (slag hammer)
- Iron brush (wire brush)

Slag residue cleaning tools were shown in Figure 5 below.

(a) (b)

Figure 5: (a) Chipping, (b) Wire brush

3.2 Types of FCAW

There are two main types of Flux-Cored Arc Welding (FCAW): self-shielded FCAW (FCAW-S) and gas-shielded FCAW (FCAW-G) (American Welding Society, 2020). Self-shielded FCAW uses a flux core that generates its own shielding gas during the welding process, making it suitable for outdoor or windy conditions where external gas shielding might be blown away. On the other hand, gas-shielded FCAW requires an external shielding gas, usually a mixture of carbon dioxide or argon with carbon dioxide, which provides a cleaner weld with less spatter and better mechanical properties. Each type has its own advantages depending on the application, material thickness, and working environment.

3.3 FCAW System Components

FCAW System Components consist of several components, which are as follows:

a. FCAW welding machine: Regulates the current and voltage required during welding.
b. Wire feeder: Sets the continuous wire output speed.
c. Welding wire (flux cored wire): Tubular type and contains flux inside. Example specification: AWS A5.20 E71T-1.
d. Shielding gas (if used): Protects the arc and weld pool from atmospheric contamination.
e. Nozzle and contact tip: Direct the wire and gas flow to the welding area.

3.4 Main Parameters

Main Parameters of FCAW Process:

a. Welding Current and Voltage: Usually uses DC current with DCEP (Direct Current Electrode Positive) polarity.
b. Wire Feed Speed: Affects the metal deposition rate and arc stability.
c. Welding Travel Speed: Determines penetration and bead shape.
d. Stick-Out Distance: The distance between the contact tip and the work surface, affects the heat and stability of the arc.

3.5 Welding Positions

Welding Positions in FCAW:
FCAW can be used in various welding positions:

- Flat (PA)
- Horizontal (PB)
- Vertical (PF)
- Overhead (PE)

Parameter settings and wire types must be adjusted to the position to achieve maximum welding results.

4.0 DISCUSSION

4.1 Welding Specifications and Parameters

The following table shows the welding parameters used:

Table1. Welding Parameter

No.	Parameter	Mark
1	Types of welding wire	E71T-1
2	Wire diameter	1.2 mm
3	Polarity	DCEP (Electrode Positive)
4	Welding current (Amperes)	180–220 A
5	Voltage)	24–28 V
6	Wire feed speed	± 250–350 in/min
7	Shielding gas (FCAW-GS)	Pure CO_2

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The Flux Cored Arc Welding (FCAW) welding process in the manufacture of supply boats at PT Vallianz is carried out systematically in accordance with the operational and work safety standards applicable in the shipbuilding industry. The preparation of FCAW welding process illustrated in Figure 6.

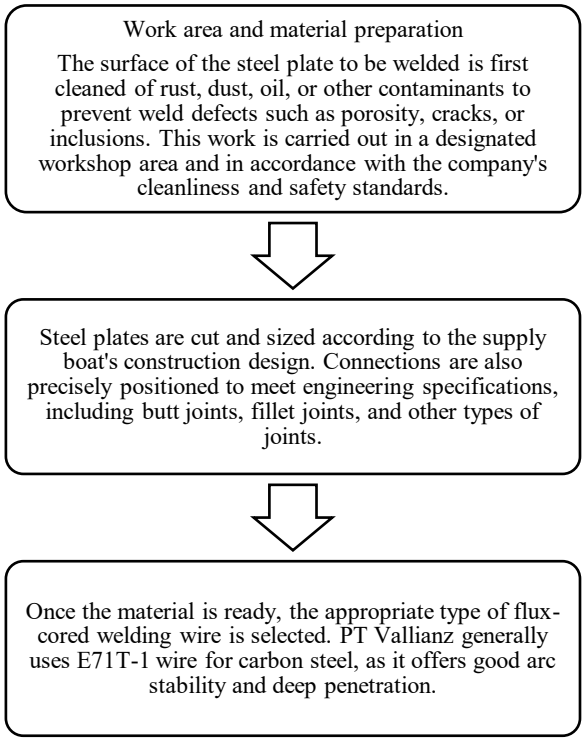


Figure 6: FCAW welding preparation

The welding machine is set with DCEP (Direct Current Electrode Positive) polarity, and other parameters such as current, voltage, and wire feed speed are adjusted according to the thickness of the material to be welded. After the wire feeder and torch are installed, the operator is required to wear Personal .Protective Equipment (PPE) such as an automatic welding helmet, heat-resistant gloves, a mask, a fire-resistant apron, and safety shoes, as a form of compliance with work safety standards at PT Vallianz. The welding process is as follows at Figure 7.

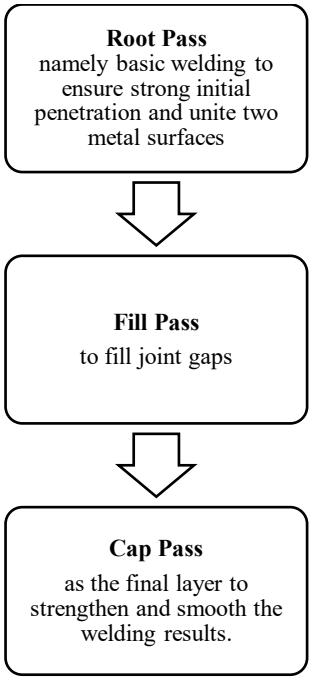
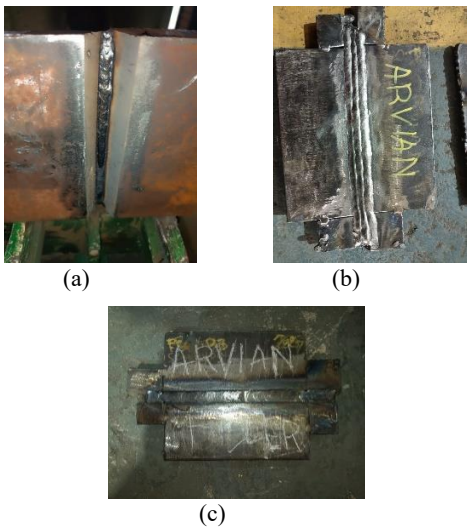


Figure 7: Welding process

The result of the FCAW welding process can be seen in Figure 8.



(a) (b)

(c)

Figure 8: Welding process (a) Root pass, (b) Stamp pass, (c) Fill pass

5.0 CONCLUSION

Based on the results of the practical work that has been carried out at PT Horizon Offshore Engineering in the process of making supply boats using the Flux Cored Arc Welding (FCAW) welding method, it can be concluded that:

FCAW is a very effective and efficient welding method. For metal joining in ship construction, particularly for medium

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to thick steel plates. Using flux-cored wire and an automatic wire feeder system, FCAW accelerates the welding process and improves weld quality and consistency.

ProcessWelding preparation is crucial to the success of a weld. From material inspection, wire selection and proper parameters, to the use of personal protective equipment (PPE) and work area security, all significantly impact the quality and safety of the welding process.

Application of welding parameters according to WPS (Welding Procedure Specification)It is very important to avoid welding defects such as porosity, cracks, incomplete fusion, and undercuts. During the practical work, parameters such as current (180–220 A), voltage (24–28 V), and wire feed speed are carefully controlled by the operator and field supervisor.

During the practical work activities, various challenges were found in implementing FCAW, such as open work environments, limited welding positions, and varying operator skills. However, these challenges can be overcome through regular training, selecting the appropriate wire type, using windshields, and strict supervision by the QC (Quality Control) team.

With rigorous quality control and systematic welding procedures, FCAW has proven to produce strong, durable joints capable of withstanding the high operational pressures of marine environments. This makes FCAW a leading choice for supply boat construction in the modern shipping industry.

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