

Procedures for Welding Techniques of Shipyard using Metal Inert Gas



Sunarso Sugeng, Sulaiman, Mohd Ridwan, Tumpal Ardyan U. Naigolan

Abstract: *The main objective of this research is to find a combination of large currents and welding speeds, to obtain optimal welding results with metal inert gas (MIG) technique. This research will conduct procedures of experimental observations of welding with variable current and speed on MIG (metal inert gas) welding, using currents ranging from 50 to 200 amperes, 1G welding position, with welding speeds ranging from very slow to very fast, it is expected to be obtained optimal welding results. Metal Inert Gas (MIG), first used in welding aluminum plates. Arc and welding wires use electrode wires that are protected by helium gas, argon gas and for carbon steel materials using CO₂ gas. MIG is an alternative to using the MMA method, offering high deposition rates and high productivity. MIG is widely used especially for welding high quality steels such as stainless steel, strong steel and non-steel metals which cannot be welded in other ways.*

Keywords : *welding techniques, shipyard, Metal Inert Gas.*

I. INTRODUCTION

To produce a skilled welder requires a minimum of 6 months of training and more, so for prospective welding inspection technicians with a minimum diploma level of education three, a fast and accurate learning method is needed to produce qualified welds. The skill of the welder in regulating the current and speed in the welding process requires knowledge of the effect of welding speed and current. This can give an idea of how an outcome of the taste can be of good value, visually and its strength meets the requirements. Welding is a technique of connecting metals by melting some of the parent metal and filler metal to produce continuous connections. The scope of the use of welding techniques in shipbuilding is very broad, including ship construction, engine foundation, ship piping installation (loading and unloading pipes, ballast pipes, fire pipes, sanitary pipes, etc.), as well as pressure vessels. A research from Sulaiman and Ridwan (2012) examined the welding of ship plates using gas fuel.

Revised Manuscript Received on October 30, 2019.

* Correspondence Author

Sunarso Sugeng*, Architecture Department, Vocational School, Universitas Diponegoro, Semarang, 50275, Indonesia

Sulaiman, Architecture Department, Vocational School, Universitas Diponegoro, Semarang, 50275, Indonesia

Mohd Ridwan, Architecture Department, Vocational School, Universitas Diponegoro, Semarang, 50275, Indonesia

Tumpal Ardyan U. Naigolan, Architecture Department, Vocational School, Universitas Diponegoro, Semarang, 50275, Indonesia

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

The importance of welding carried out on the ship's plate is that it must consider various factors in the welding process so that good weld quality is obtained. Another result showed that fairing process had an effect on the properties of the mechanical extension of the ship plate (Sulaiman, 2012). Welding technology is currently developing rapidly, including: manual methods such as shielded metal arc welding (SMAW), semi-automatic inspection such as gas metal arc welding (GMAW), submerge arc welding (SAW), flux core arc welding (FCAW) and electro slag sherd, laser beam welding, and electron beam welding (Kapoor & Ogborn, 2008). Besides, there are robot welding techniques that have been widely applied in various industries. Metal Inert Gas (MIG) or Metal Arc Welding (GMAW) is a welding process where arcs and welding pools formed using bare wire electrodes are protected by helium gas, argon gas or mixtures thereof. MIG is popular in the UK for welding aluminum using argon as a protective gas, and for carbon steel using CO₂ gas. MIG uses direct current (50 dd. 600 DC-ampere, 15 volts dd. 35 volts) (Singh, 2015). MIG is similar to MMA where heat for welding is produced by forming an arc between metal electrodes and workpieces; the electrode melts to form a weld bead. The main difference is that metal electrodes are small diameter wires fed from spools and that a protective gas is supplied from outside. Because the wire is continuously fed, this process is often called semi-automatic welding.

II. STATE OF THE ART

The main objective of this research is to find a combination of large currents and welding speeds, to obtain optimal welding results. The importance / urgency of this research plan is obtained by a combination of large currents and welding speeds, in order to obtain the best weld results and meet the standards, both from the visual and its strength. This result will be a guideline in shortening the time to train welders. Contribution of the results of activities is to produce appropriate technology in producing standard welding procedures with the metal inert gas method. The target of research innovation is the use of varying welding current with welding rate and ultimate tensile strength (UTS) of carbon steel, which can be used as a guideline for welding using the metal inert gas (MIG) method.

The influence of the welding current on the welding speed and ultimate tensile strength of mild steel materials was investigated by Nutalapati et al. (2016). Mild steel welding uses various welding currents namely: 90, 95 & 100 amperes using the MMAW process in 1G position.

Procedures for Welding Techniques of Shipyard using Metal Inert Gas

Preparations were made for the test specimen, electrode diameter and electrode type, welding techniques, polarity and welders remained constant during the test. The results showed that with an increase in welding current, the electrode melting rate increased causing a reduced welding time.

The activity of welding of ship plates starts from the preparation of the plate to be used, marking, cutting and fabrication. When cutting plates and welding using gas-fired welding, it should be noted that the form of ignition will affect the quality of cutting or welding and provide an economical level of gas usage (Sulaiman & Ridwan, 2012). The level of welding effect on the productivity assessment in shipyard industry was also examined in Sulaiman et al. (2017).

III. METAL INERT GAS (MIG)

Metal Inert Gas (MIG), first used in welding aluminum plates (see for broader meaning in Weman & Lindén, 2006). Tong et al. (2001) tested the welding of aluminum alloy thin sheets using an inert gas (MIG) pulsating gas source alternating current (ac). Moreira et al. (2007) tested the fatigue behavior of two aluminum alloys in a comparison model between FSW and MIG welding. By analyzing the modified gas inert gas welding process, Zhang et al. (2007) tested the interfacial microstructure and mechanical properties of aluminum-zinc-plated steel joints (for comparison tests, see Zhang & Kong, 2012). Arc and welding wires use electrode wires that are protected by helium gas, argon gas and for carbon steel materials using CO₂ gas. MIG is an alternative to using the MMA method, offering high deposition rates and high productivity (see for example testings in Martina et al., 2019; Thivillon et al., 2009; Kanemaru et al., 2014). MIG is widely used especially for welding high quality steels such as stainless steel, strong steel and non-steel metals which cannot be welded in other ways.

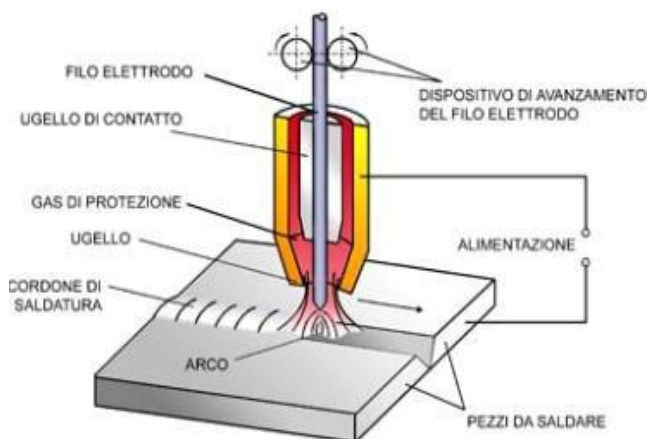


Figure 1. MIG arc welding

MIG welding uses reverse polarity and electrode wires with diameters between 1.2 to 2.4 mm. MIG welding with high currents and electrode wires with diameters between 3.2 and 6.4 mm to weld thick aluminum plates such as liquefied natural gas storage tanks. MIG welding is usually used with fixed velocity electrode wires by means of pull or push feeding.

IV. PROCEDURE

The initial step of research is to make test specimens from steel, carbon steel with a size of 100 mm x 25 mm x 6 mm. the specimen is cleaned of dust and viscous lubricants and other foreign materials. The sides of the plate to be welded are formed at an angle of 30o, 45o and 60o (single V butt joint) with a weld root spacing of 1 mm. The results of this welding are carried out bending using a bending machine and test Pull the carbon steel material using a universal testing machine. Figure 2 displays the required pessimistic tests, and Table 1 displays the equipment, test measurements, and procedures for tensile and stretch testing on welding with metal inert gas (MIG).

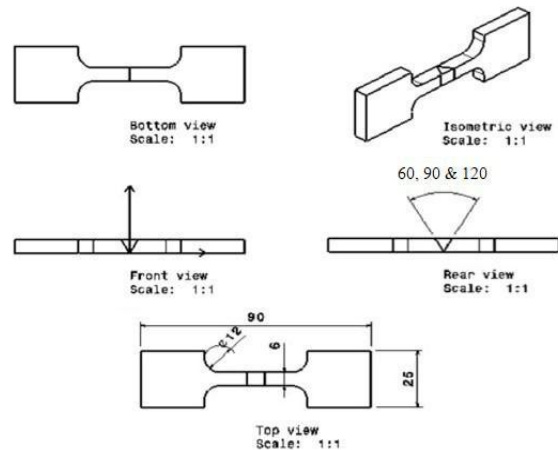


Figure 2. Specimen Test

Table 1. The equipment, test measurements, and procedure

Equipment	Measurement test	Procedure
Pull Test Machine	Limits of proportionality	Measuring the length and diameter of the original specimen.
Test Specimens	Elastic limit	Place the specimen into the vise of the test machine
Scale	Yield strength	Start running the test machine, record the data generated by the machine.
Vernier Caliper	Highest strength	Reading data more closely when the results point when it approaches the ultimate point.
	Modulus of elasticity	Measuring the extension value with the help of dividers and rulers.
	Percentage of lengthening	Continue the test until a break occurs
	Percentage reduction in cross section	Bringing together two broken parts of the specimen, measure the final dimensions of the specimen.

V. CONCLUSION

Welding is a technique of connecting metals by melting some of the parent metal and filler metal to produce continuous connections. The scope of the use of welding techniques in shipbuilding is very broad, including ship construction, engine foundation, ship piping installation (loading and unloading pipes,

ballast pipes, fire extinguishers, sanitary pipes, etc.), as well as pressure vessels. Welding quality is highly dependent on selection of welders' tools, methods and skills. The skill of the welder depends on the welding hours that have been done.

With this explanation of required equipment, measurement, and procedures, it is hoped that, skilled welders can arrange strong current (the current is too large causing the electrode to melt quickly and the welding quality is poor, the current is too small causing the electrode to be difficult to melt and the weld will clot), electrode displacement speed (if it is too fast, the weld copy is shallow, less time to warm the base material and the electrode fluid does not penetrate too slowly, it will produce a wide, rough weld path). Welders to reach the skilled level with the method of MIG (metal inert gas) or GMAW (metal arc welding) require a very long training time or hours of welding, so research is needed to determine the exact composition between the regulation of current strength and the speed of welding electrode transfer, so produces good welding quality (visually good and strength meets material test standards). The results of this study are very useful for instructors at ship welding workshops, in providing knowledge and skills to welders, or welding inspection technicians, especially for MIG (metal inert gas) or GMAW (metal arc welding) welding methods.

REFERENCES

1. Kanemaru, S., Sasaki, T., Sato, T., Mishima, H., Tashiro, S., & Tanaka, M. (2014). Study for TIG–MIG hybrid welding process. *Welding in the World*, 58(1), 11-18.
2. Kapoor, A., & Ogborn, J. (2008, January). Development of High Strength SMAW Consumables for SBD Applications. In *The Eighteenth International Offshore and Polar Engineering Conference*. International Society of Offshore and Polar Engineers.
3. Martina, F., Ding, J., Williams, S., Caballero, A., Pardal, G., & Quintino, L. (2019). Tandem metal inert gas process for high productivity wire arc additive manufacturing in stainless steel. *Additive Manufacturing*, 25, 545-550.
4. Moreira, P. M. G. P., De Figueiredo, M. A. V., & De Castro, P. M. S. T. (2007). Fatigue behaviour of FSW and MIG weldments for two aluminium alloys. *Theoretical and applied fracture mechanics*, 48(2), 169-177.
5. Notalapati, S., Azad, D., & Naidu, G. S. Effect of welding current on welding speed and ultimate tensile strength (UTS) of mild steel. *International Journal of Mechanical Engineering and Technology* 7(5), 156 - 176
6. Singh, R. (2015). *Applied welding engineering: processes, codes, and standards*. Butterworth-Heinemann.
7. Sulaiman, & Ridwan, M. (2012). Pengelasan plat kapal menggunakan bahan bakar gas. *Kapal: Jurnal Ilmu Pengetahuan dan Teknologi Kelautan*, 5(3), 202-205.
8. Sulaiman, S. (2010). Pengaruh Proses Fairing Terhadap Sifat Mekanis Sambungan Pelat Pada Bagian Lambung Kapal. *Journal of Gema PS DIII FT-Undip*, 1-9.
9. Sulaiman, Sasono, E.J., Susilo, S., & Suharto. (2017). Factors affecting shipbuilding productivity. *International Journal of Civil Engineering and Technology* 8(7), 961 - 975
10. Thivillon, L., Bertrand, P., Laget, B., & Smurov, I. (2009). Potential of direct metal deposition technology for manufacturing thick functionally graded coatings and parts for reactors components. *Journal of Nuclear Materials*, 385(2), 236-241.
11. Tong, H., Ueyama, T., Harada, S., & Ushio, M. (2001). Quality and productivity improvement in aluminium alloy thin sheet welding using alternating current pulsed metal inert gas welding system. *Science and Technology of Welding and joining*, 6(4), 203-208.
12. Weman, K., & Lindén, G. (Eds.). (2006). *MIG welding guide*. Woodhead Publishing.
13. Zhang, H. T., Feng, J. C., He, P., & Hackl, H. (2007). Interfacial microstructure and mechanical properties of aluminium–zinc-coated steel joints made by a modified metal inert gas welding–brazing process. *Materials characterization*, 58(7), 588-592.
14. Zhang, Z., & Kong, X. (2012). Study on DC double pulse metal inert gas (MIG) welding of magnesium alloy. *Materials and Manufacturing Processes*, 27(4), 462-466.