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A Study of Feasibility of Magnetic Oscillate Gas Tungsten Arc Welding with Fluxed Core Filler Metal for Weldability Improvement

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Abstract

The application of Gas Tungsten Arc Welding with embedded solid wire is widely used among the industry. In order to gain higher welding property, it is necessary to add the chemical compositions in the welding wire, which is quite difficult comparing with other kinds of welding wires such as fluxed core. Nevertheless, it appears that the addition of fluxed core in the welding leads to the defect such as porosity, inclusion, and undercut, which negatively affects the weld. To eliminate this problem, the plasma was oscillated by the magnetic field. This action leads to the better circulation of metal water in the weld pool. This experiment aims to compare the welding with nonmagnetic field and with magnetic field for the groove weld. The material used is A516 Grade 70. The findings indicate that, comparing with welding nonmagnetic field, welding with magnetic field can eliminate the defect in the welded pass. Second, examining the welded pass mechanical property, welding with magnetic field gives the better mechanical property than welding with nonmagnetic field.

Keywords: *Welding parameter, Resistant-Spot-Welding, High Strength Steel*

1. Introduction

There is a study about the feasibility of using magnetic in Arc Beam oscillate in Gas Tungsten Arc Welding (GTAW). The report aims to increase weldability such as undercut, porosities, and to increase the welding speed. The application of Arc Beam oscillate gives the best result in decreasing the material cracks that is easy for the crack such as aluminum alloy, Hy-80, and other kinds of alloy. It is now widely used in industry to design trade products for weld. The Semi Auto GTAW by feeding solid wires is widely used in the industry. [1-3] However, to increase the ability of weld, controlling the features extremely for Root Pass is difficult to add alloy in solid wires. Comparing with Fluxed Core Wire which is better in feeding, increasing strength, and protecting defects, and possibly to decrease levels of the material defect by Flux design.

The use of GTAW and Semi Auto Fluxed Core Filler Metal is truly used. A report said that there were defects in the weld. ASME BPV code section IX [4] identifies the need to prove the ability of

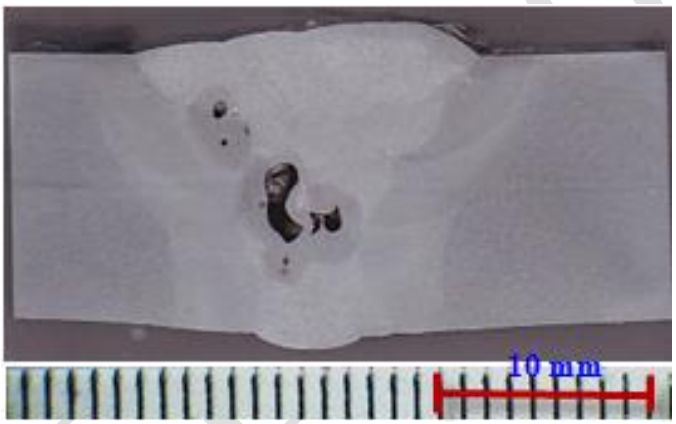
this procedure from switching solid wire to Fluxed Core. This is to ensure that the welding from the procedure above is suitable for the fabrication and service.

Thus, this research aims to apply the procedure about Gas Tungsten Arc Welding with Magnetic Arc Oscillation in order to increase the ability in welding with Fluxed Core Filler Wire. The expectation of this success can lead to the development of the procedure, which boost the potential ability in production and increase the welding properties.

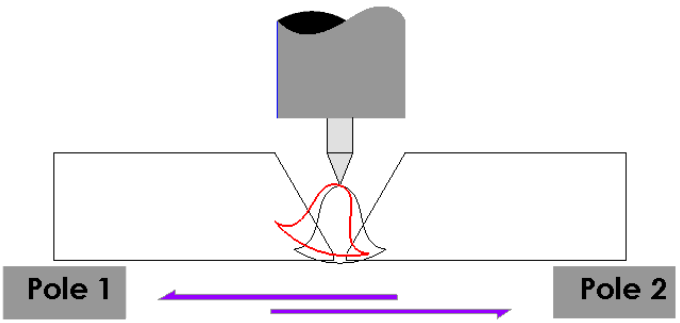
2. Research methodology

2.1 Magnetic oscillating system

Picture 2 displays the method of Arc Beam oscillate in cross-section. It aims to, first, intensify arc for melting groove surface (base metal). The oscillate arc beam is distorted and becomes smaller. This increase the intensive of heat and lead to melting. Second, oscillate the arc to stir the melting pond which lead to diminish the slag inclusion because of the sensitivity of Fluxed Core Filler Wire.



Picture 1 macro section from Semi-automatic GTAW with fluxed core wire



Picture 2 displays the method of Arc Beam oscillate in cross-section

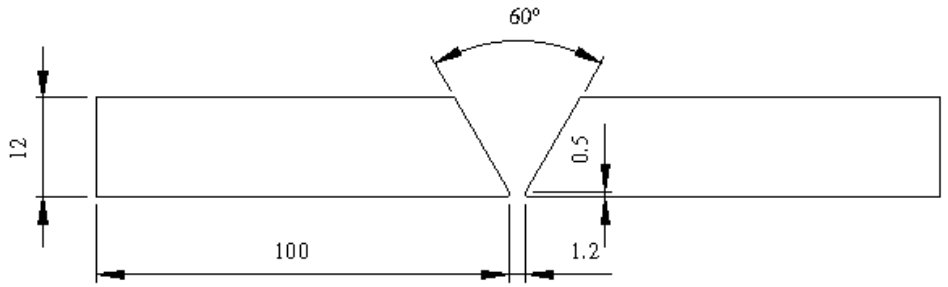
2.2 Materials

Base metal used in this study is A516 Grade 70. It is used for constructing pressure vessel. It is 12 mm. thick. Tensile is 371 N/mm^2 and strength is 534 N/mm^2. respectively. Also, the chemical composition is indicated in Table 1. In Semi auto GTAW process, the specimen is prepared as 100

mm. wide by 200 mm. long with 12 mm. thick. Picture 3 illustrates the preparation of groove surface. They were varied in sizes and all of them were already tested, which are suitable for this process.

Table 1 Chemical composition of base metal and filler metal

Material	C	Si	Mn	Mo	Cr	Cu	Ni	C.E.
Filler metal	0.234	0.344	1.202	0.002	0.020	0.01	0.008	0.43

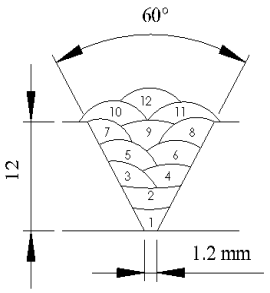


Picture 3 Specimen dimension and groove configuration

2.3 Welding procedure

This study aims to qualify the welding procedure qualification; therefore, the design of pre-welding procedure specification, as shown in Table 2 and 3: common GTAW and magnetic oscillate GTAW. Complete joint penetration is required for 12-mm.-thick multi-pass weld. Regarding plasma oscillate, the oscillating frequency is 1 Hz, which is in line with welding speed at 11 meters per minute. During the weld interpass process, the weld interpass is cleaned and inspected by Visual Inspection to assure that there is no slag left, which is caused from ineffectiveness of weld interpass cleaning and temperature controlling is not over 100 degree Celcius.

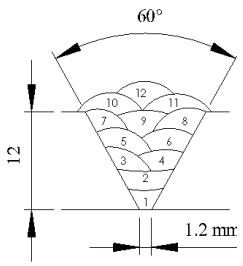
Table 2 Welding procedure specification of common semi auto GTAW with fluxed cored wire (E71T-1C)

Pass or weld layer(s)	Process	Filler Metals		Current		Volts	Travel Speed	Joint Details
		Class	Diam.	Type & Polarity	Amps or Wire Feed Speed			
All	GTAW	E71T-1C	1.2	DC-	170 A	12-16 V	10m/min	

2.4 Quality inspection after welding.

The weld-tested item is examined by nondestructive testing radiographic testing. It aims for investigating the defect and comparing fabrication weld ability by radiographic testing, based on ASEM BPV code section IX. Nonetheless, the tested items examined by radiographic test, if there is no defect, it will be selected to be cut to test the mechanical property of the weld in the next step. In addition, macro cross-section is randomly cut to analyze the macro weld result by metallurgical standard method. 3 ml Nitric Acid with 100 ml distilled water are mixed, and soaked these tested items for 10 seconds..

Table 3 Welding procedure specification of magnetic arc oscillate semi auto GTAW with fluxed cored wire (E71T-1C)

Pass or weld layer(s)	Process	Filler Metals		Current		Volts (V)	Travel Speed (mm/min)	Magnetic 2 Direct. (1Hz)	Joint Details
		Class	Diam.	Type & Polarity	Amps & Wire Feed Speed				
All	GTAW	E71T-1C	1.2	DC-	170 A	12-16	100	200 G	

2.5 Sound weld metal inspection by destructive testing: bending

The objective for side bending test is to prove this procedure whether it is able to construct sound weld metal. The preparation for the bend test is based on AWS D1.1 Standard. The radius of plunger is 50 mm. The evaluation is considered by selecting the bending weld pass. If the crack, as the overall, is over 10 mm. (based on ASEM BPV code section IX), it is considered that this welded pass is not qualified.

2.6 Mechanical Testing: Tensile

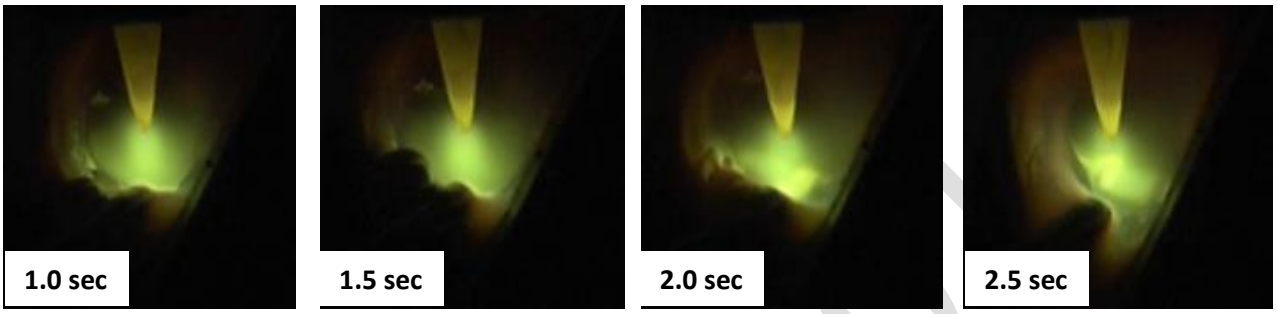
The purpose of tensile test is to prove that whether this procedure is durable enough for welding. The preparation for tensile test is based on ASME Section IX-QW 15.1. The method for testing is based on ASTM-E8. The evaluation is considered by comparing tensile of the two procedures.

3. Result and discussion

During the weld process, displayed via video, common weld and magnetic oscillate, respectively. The observation via video, for common weld, it shows that wire feeding is stable and the construction of weld pool is good. On the other hand, the oscillation helps stir magnetic liquid metal obviously. The results from these two samplings were examined by radiographic testing in order to investigate the level of defect occurrence in the weld metal.

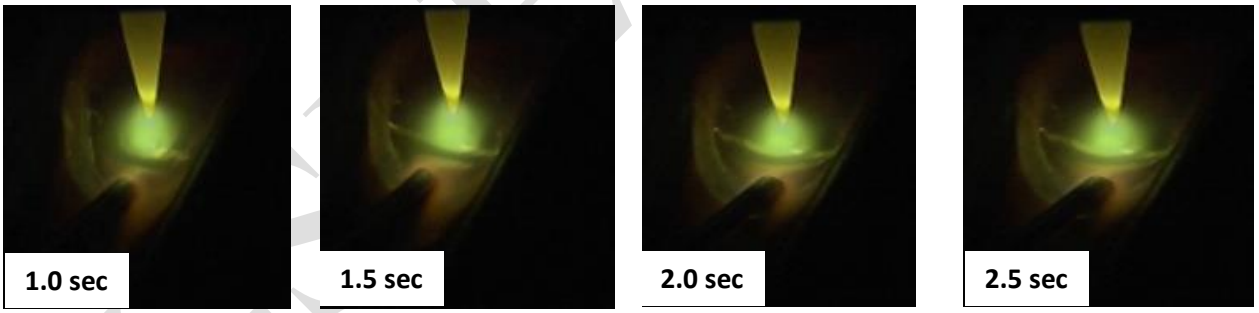
Picture 6 shows a large amount of defect in fluxed core GTAW. According to the interpretation, it indicates that the defect is slag inclusion. This is in accordance with the occurrence of feeding wire.

Although the results from this procedure can operate the stable system, the quality inside the weld metal expresses 4.39 % defect as one unit per weld metal length. Considering magnetic oscillates GTAW, picture 7 illustrates the ability to construct sound weld obviously. This experiment shows, in terms of the feeding fluxed core wire, magnetic oscillate can increase higher efficiency for fabricating weldability than common GTAW.

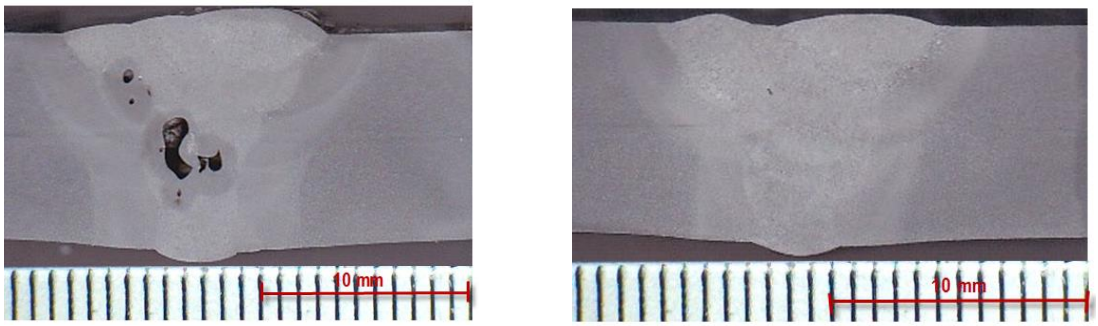


Picture 4 Process Monitoring of magnetic oscillate GTAW

Sound Weld Metal is proved in the macro level in cross-section weld, as shown in picture 8 for common GTAW and magnetic oscillate GTAW. The findings appear that the occurrence of slag inclusion in common GTAW occur inside the weld metal, not from the inefficiency cleaning between the interpass. The cause of slag inclusion may be from the common weld solidifying faster earlier before the flux floats to the surface of weld metal. On the contrary, the result from magnetic oscillate indicates the sound weld metal obviously. Furthermore, the result form monitoring via video ensures that stirring the weld pool leads to the flux floating faster. Consequently, the defect is decreased.



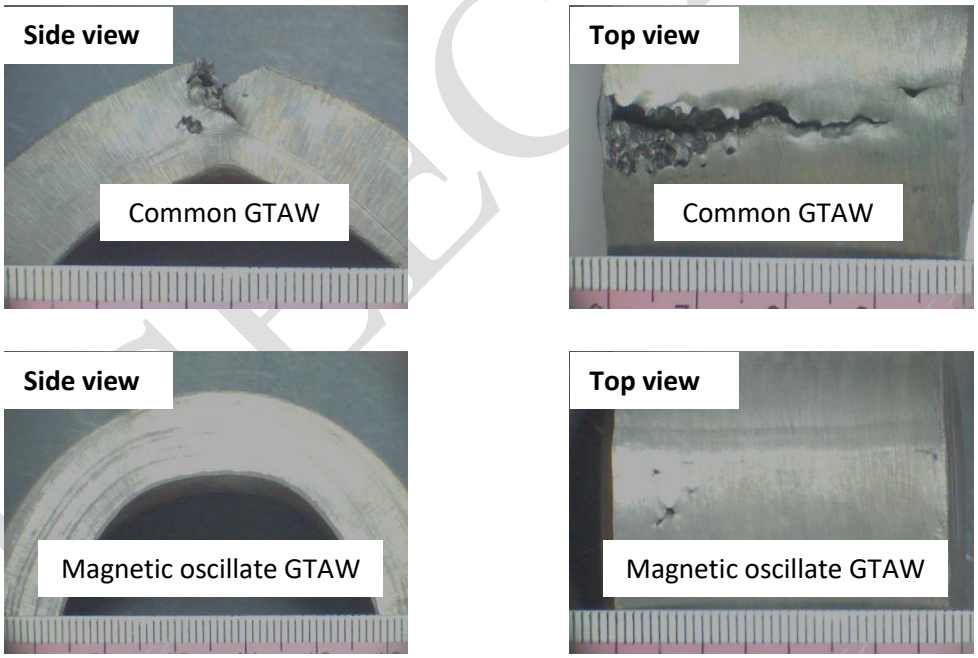
Picture 5 Process Monitoring of common GTAW (nonmagnetic)



Non-Magnetic oscillate GTAW Magnetic oscillate GTAW

Picture 6 Macro cross section of common GTAW and magnetic oscillate GTAW

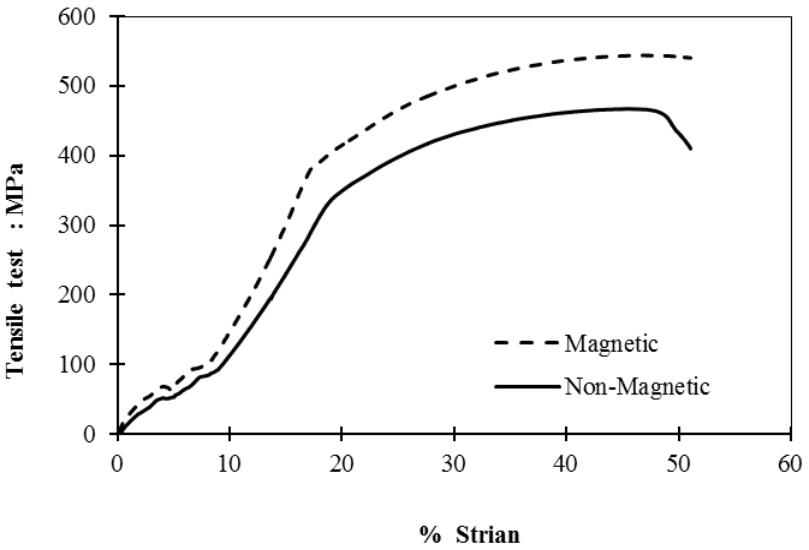
The inspection for the mechanical property for the examination of service weldability consists of bend test and tensile test. Picture 9 displays common GTAW, a large amount of slag inclusion appears. As a result, a crack on the tested items appears on the convex surface severely. Regarding magnetic oscillate GTAW, a few crack appears on the tested items, the overall defect is less than 3 mm, it is qualified.



Picture 7 Bend test

Photo

28 mm x 35 mm



Picture 8 Stress-strain results of common GTAW and magnetic oscillate

4. Conclusion

The development of Magnetic Arc Oscillate GTAW: Semi Automatic Process with Fluxed Core Filler Metal of E71T-1 grade is very successful for Multi Pass Weld on Single V Groove type, 12 mm thick, base metal 516 Grade 70. This procedure can be used with both fabrication weldability and service weldabilty. In addition, this procedure is better than common GTAW because it can be seen that the amount slag inclusion is eliminated obviously.

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