JMM: Journal of Mechanical and Manufactur
Vol. 2 No 2, April 2023 , pp. 49-56
DOI: 10.31949/jmm.v2i2.4364
e-ISSN: 2829-4424

THE EFFECT OF VARIATION OF WELDING CURRENT ON 6061 ALUMINUM PIPE ON MECHANICAL PROPERTIES AND MICRO STRUCTURE USING TIG WELDING

Aa Santosa[1], Viktor Noubnome[2], Maulana Candra Muhkti[3]
[1,2,3] Universitas Singaperbangsa Karawang
[1]aa.santosa@ft.unsika.ac.id [2]viktornaubnome@staff.unsika.acid [3]Maulanacandramaul@gmail.com

Abstract
TIG welding is a welding technique for connecting metals using tungsten rod electrodes and using noble gas as a protective gas which is exhaled on the weld metal to protect against contamination with the surrounding atmosphere. Aluminum metal is a metal that has a high affinity for absorbing H2, N2 and O2 in the air at high temperatures, so it is necessary to have a high purity protective gas during the welding process, because N2 H2 and O2 will cause a decrease in the corrosion resistance of the material. To find out the effect of the TIG welding process on the mechanical properties and microstructure, a study was carried out to determine the mechanical properties, namely hardness, and bending properties, as well as the microstructure found in aluminum after the tungsten inert gas welding process was carried out using current. different. In this study the welding process used the Tungsten Innert Gas process by varying the welding current, namely 100 A, 130 A and with a welding time of 2.5 seconds, 4.5 seconds, . So that from the welding parameters used, it will be known the effect of the welding parameters
Keywords : *Welding Current, Alumnium Metal, TIG welding*

Submitted: yyyy-mm-dd	Revised: yyyy-mm-dd	Accepted: yyyy-mm-dd

Introduction

The use of metal materials to support human life continues to grow along with the rapid development of science and technology. This greatly influences the technology to process it into a ready-to-use product. Among the production techniques used to make a product is the welding process [1] Welding is a method of joining that is widely used in steel building construction and machine construction. Another connection method used on metal joints is bolts and rivets. Welding technology, besides being able to be used to join and cut metal, can also be used to fill holes in castings, make hard coatings on tools, thicken worn parts, and other kinds of repairs [1] Welding is one way to connect solid objects to the road. Factors that influence the results of welding are welding procedures, namely the method of making welding construction according to plans and specifications by determining all the things needed in the implementation. The welding production process in question is the manufacturing process, the tools and materials needed, the order of implementation, the preparation for welding (includes: selection of welding machines, appointment of welders, selection of electrodes, use of seam types). The research conducted was to test the aluminum 6061 material which underwent a welding process using TIG welding using different parameters of current and welding time, namely 100 A and 130 A. The times used were 2.5 seconds and 4.5 seconds.
The aims and objectives of this research are

1. Knowing the mechanical properties, namely hardness, and bending properties, which are found in aluminum 6061 after the inert gas tungsten welding process is carried out using different currents.
2. Knowing the effect of different currents on the properties of the microstructure in the weld Area.

Research Methods

In this research process using Zircaloy Grade 1 base material in the form of a pipe with a thickness of 2.8 mm. As for the shape of the material as shown in Figure 1. below this

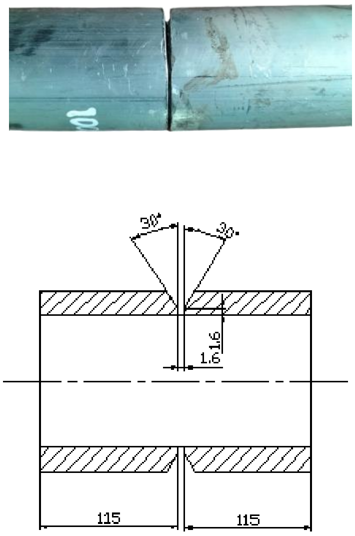


Figure 1. Starting materials

Before the specimen is welded, the surface preparation process is carried out using sandpaper, then cleaning the entire surface of the material with acetone is carried out. This is done to clean the material from dirt

Tungsten Innert Gas Welding Process

In this study welding using a welding machine with the following specifications:
Maximum voltage : 28 V Power Source:
Direct Current (DC) Current Polarity: Straight Conditions at the time of welding are: Welding process:
Manual Shielding gas : Argon Electrodes:
Tungsten Filler Metal : Zirconium Grade 1 Electrode Diameter: 2 mm
Welding Current: 100 A, 130 A,
Welding time: 2.5 seconds, 4.5 seconds.

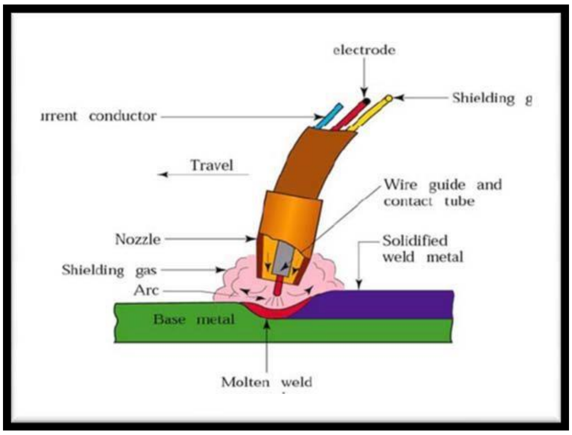


Figure 2. Welding Proces TIG

Groove Making Process

The groove design is chosen based on the thickness of the material used and the ease of processing, in this case the selected groove is the Single V butt joint. For making grooves for making a single V welding groove, it is done by grinding process The welded pipe is a pipe with a diameter of 2 inches with a length of 125 mm. After cutting the material, then the process of making welded seams is carried out, followed by the TIG joining process. The sequence of how the TIG equipment works is as follows: a. Placement of workpieces that have undergone a surface cleaning process. b. Use safety equipment in the form of gloves, leather jackets and eye protection helmets. c. Insert the tip of the electrode in the electrode holder. d. Setting the welding machine with the current according to the needs, then the machine is turned on. e. Perform the welding process on aluminum material In the welding process energy is required to melt the metal parts to be joined. In TIG welding, electrical energy is converted into heat energy. This heat energy is the result of the collaboration of the parameters of welding current, welding voltage, and welding speed. The quality of oral results depends on these three parameters. The relationship between these three parameters produces welding energy which is called Heat Input. In this study the parameters used are The welding current is varied to 100 – 130 A with a voltage with a welding time of 2.5 seconds and 4.5 seconds.

Bending Test

The bending test is carried out to check the welding results by bending the test specimen to form an angle of 180° with a slow bending speed, then to examine and analyze it with reference to existing test standards. The manufacture of bending test specimens refers to the ASTM E23-02 standard for bending tests as shown below

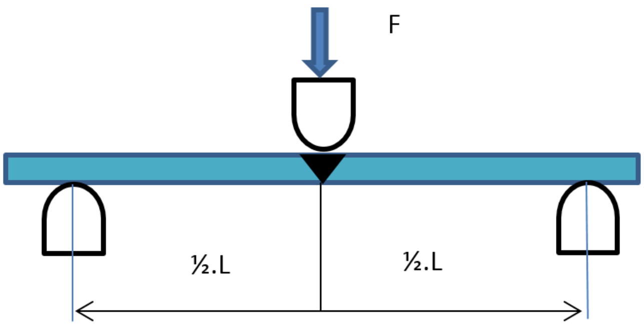


Figure 3. Bending Test Scheme

Machine Data The maximum load capacity of the bending machine is 4 tons Bending Process Type: Root Bending.

Table 1 Bending Process Results on Welding specimens.

Tipe Spesimen	Hasil Uji Sampel				Remark T, L, F, S (*)
	100 A -2,5	100 A -4,5	130 A-2,5	130 A-2,5	
Root-bend	Crack	Crack	No Crack	No Crack	T

Table 2 Data from the calculation of bending strength in the welding process

Test Parameters	Formula	Test results	Information
No Identitas 100 A -2,5			
Initial diameter, (mm)	d	50,8 mm	
Initial thickness, (mm)	b	2,8 mm	
Span length(mm)	l	250 mm	
Maximum Compressive Load, Fmax (kgf or N)	P_{max}	4000 kgf	
Bending Strength ,σb (kgf/mm2 or N/mm^2)	$\sigma b = \frac{3pl}{2bd^2}$	0,21 kgf/mm^2	
Fault Location		Weld area	

Parameter Uji	Formula	Test results	Information
No Identitas 100 A -4,5			
Initial diameter, (mm)	d	50,8 mm	
Initial thickness, (mm)	b	2,8 mm	
Span length(mm)	l	250 mm	
Maximum Compressive Load, Fmax (kgf or N)	P_{max}	4000 kgf	
Bending Strength ,σb (kgf/mm2 or N/mm^2)	$\sigma b = \frac{3pl}{2bd^2}$	0,21 kgf/mm^2	
Fault Location		Weld area	

Parameter Uji	Formula	Test results	Information
No Identitas 130 A-2,5			
Initial diameter, (mm)	d	50,8 mm	
Initial thickness, (mm)	b	2,8 mm	
Span length(mm)	l	250 mm	
Maximum Compressive Load, Fmax (kgf or N)	P_{max}	4000 kgf	
Bending Strength ,σb (kgf/mm2 or N/mm^2)	$\sigma b = \frac{3pl}{2bd^2}$	0,21 kgf/mm^2	
Fault Location		No fracture occurred	

Parameter Uji	Formula	Test results	Information
No Identitas 130 A-2,5			
Initial diameter, (mm)	d	50,8 mm	
Initial thickness, (mm)	b	2,8 mm	

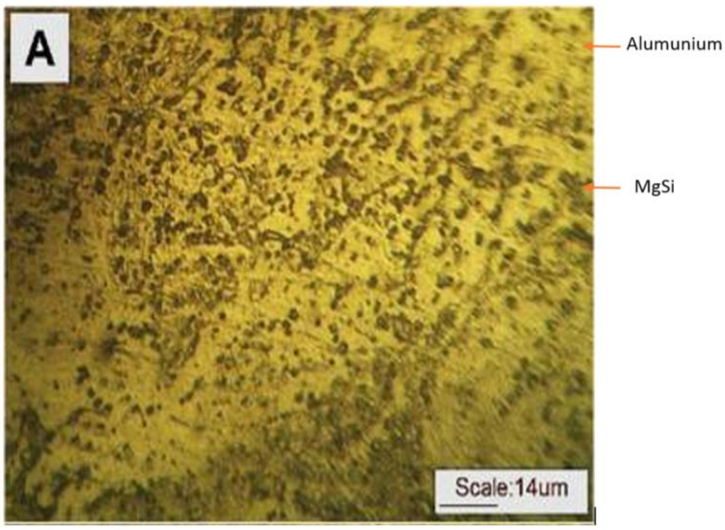
JMM :
Journal of Mechanical and Manufactur [Vol. 2, No. 2, April, 2023, pp. 49-56]

Span length(mm)	l	250 mm	
Maximum Compressive Load, Fmax (kgf or N)	P max	4000 kgf	
Bending Strength ,σb (kgf/mm2 or N/mm^2)	$\sigma b = \frac{3pl}{2bd^2}$	0,21 kgf/mm^2	
Fault Location		No fracture occurred	

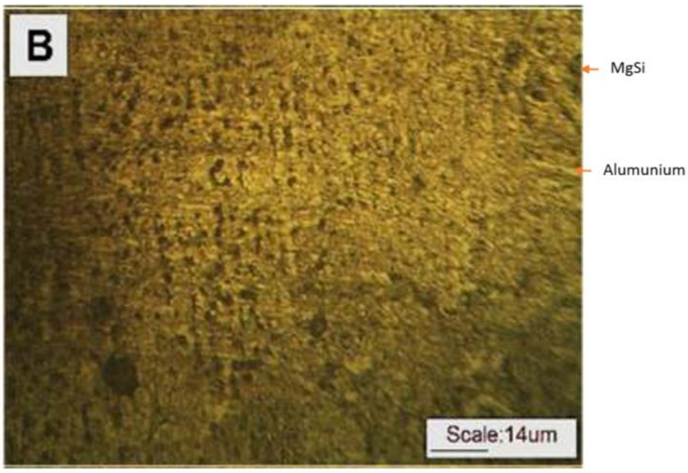
Metallographic Test Results

From the results of the photo testing of the microstructure, it can be seen that there is a change in the composition of the microstructure in the weld metal, for each current variation. This change in the microstructure of AI 6061 is caused by the heat input given during the welding process. The difference in the microstructure of the three current variations used results in different welding strengths. Aluminum 6061 is an AI-Mg-Si alloy. In the microstructure photo test, there are dark colored particles. The dark area shows the compound Magnesium Silide (Mg2Si). Mg2Si is a combination of magnesium and silicon. This compound is insoluble and appears as dark colored particles, whereas in the bright region it is Aluminum Solid Solution. The Mg2Si content in AI 6061 greatly influences the mechanical strength of the material. The more levels of Mg2Si in AI 6-61, the higher the tensile strength and hardness

1. 100 A speed 2.5 seconds



2. 100 A Speed 4.5 seconds



3. 130 A Speed 2.5 seconds

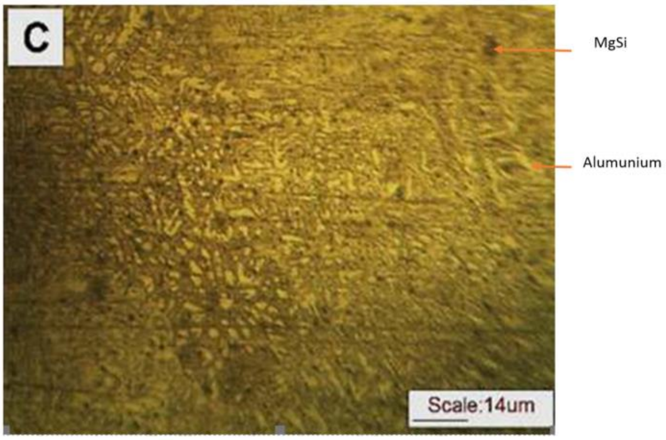


Figure 4. Structure Micro

Hard Test

The process of hardness testing is carried out to see the mechanical properties that occur in the weld metal, the method used is the Vikers method.

1. 100 A speed 2.5 seconds
   HV1 52
   HV2 50
   HV3 51

2. 100 A spedd 4,5 detik
   HV 1 51
   HV 2 53
   HV 3 50

3. 130 A Kecepatan 2,5 detik
   HV 1 58

JMM :
Journal of Mechanical and Manufactur
[Vol. 2, No. 2, April, 2023, pp. 49-56]

HV 2	59
HV 3	58

Figure 5. Hard Test

Conclusion

The process of joining two pieces of metal by using a welding process is a technology that is currently widely used as in the field of construction, one of the parameters that affect the strength of the weld is the current strength used for the welding process. Research that has been carried out on aluminum 6061 material using currents of 100 A and 130 A with a welding time of 2.5 seconds and 4.5 seconds produces different properties and strengths. The magnitude of the welding current, which also means the amount of heat input, will determine the ability of the heat to change the microstructure of the metal being welded, which also means changing the mechanical properties of the material. The use of low currents will result in low penetration compared to the use of high currents which will result in deep penetration. with a small number of layers. High currents or high heat input cause high grain growth which causes the grains to become coarse, coarse grains cause the flexural strength of the joints to become low or the joints to become brittle, apart from using high currents there are defects in the material. The resulting hardness shows that the higher the current the violence will increase, from the results of the bending test it shows that the results of the welding crack occur in the weld area at a lower current, in other words, the higher the current, the weld results do not experience cracks in the weld area.

Reference

N. U. P. K. C. D.K. Pratiwi1*, "Pengelasan Smaw Baja Karbon Rendah Dengan Yang Di Quenching Dan Normalizing," *Fakultas Teknik Universitas Sriwijaya,* 2017.

I. B. Cahya Sutowo, "Analisa Pengaruh Pengelasan Tig dan Mig pada Sambungan Las dengan Material Tipe Ss316 dan Ss304," *Universitas Muhammadiyah Jakarta, Jurusan Teknik Mesin,* 2008.

S. M. Rudi Siswanto, Buku Ajar Teknologi Pengelasan, Banjarmasin: Program Studi Teknik Mesin Fakultas Teknik. Universitas Lambung Mangkurat, 2018.

M. T. Q. Amin Nur Akhmadi1, "ANALISA HASIL PENGELASAN 2G DAN 3G DENGAN BAHAN PLAT BESI ST 40 KETEBALAN 10MM DAN VOLTASE 20 - 35 MENGGUNAKAN MESIN LAS MIG," *Journal Mechanical Engineering, Politeknik Harapan Bersama, ,* Vols. 9, No 2, 2020.

S. M. I. S. M. Mulyadi, Teknologi Pengelasan, Sidoarjo: Universitas Muhammadiyah Sidoarjo, 2020.

B. H. K. A. S. Mohruni(1), "Pengaruh Variasi Kecepatan Dan Kuat Arus Terhadap Kekerasan, Tegangan Tarik, Struktur Mikro Baja Karbon Rendah Dengan Elektroda E6013," *Jurusan Teknik Mesin, Fakultas Teknik, Universitas Sriwijaya.*

Z. T. R. Saifuddin A.Jalil1, "ANALISA KEKUATAN IMPAK PADA PENYAMBUNGAN PENGELASAN SMAW MATERIAL ASSAB 705 DENGAN VARIASI ARUS PENGELASAN," *Jurnal Polimesin,* Vols. 2, Nomor 2, 2017.