Review of MIG and TIG welding current variation of low-carbon steel materials based on tensile strength

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Abstract. SS400 and ASTM A36 a low-carbon steel materials that are used in the industry in the connection process to create materials according to the design. The aim of this research is to review the mechanical properties that occur in low-carbon steel materials in the MIG and TIG welding process with current variations and provide advice on low-carbon steel in welding. The materials used are ASTM A 36 and SS 304 steel. MIG welding uses a plate with a thickness of 6mm and uses AWS A5.18 ER 705-6 electrode diameter of 1.2mm. TIG welding uses a cylinder with a diameter of 6mm. The method of this review reported the tensile strength of low-carbon steel ASTM A36 with current variations of 150, 155, and 160A for MIG. Current variations of SS304 low-carbon steel are 80, 100, and 120A for TIG. The result of tensile strength with the MIG process produces the highest average current of 150 A of 354.92MPa. The results of tensile strength TIG process for 100A of 1007.31 MPa. The suggestion of this review is in MIG welding a greater current is required to obtain a high tensile strength value than the current required for TIG welding on low-carbon steel ASTM A 36 with a carbon content of 0.29% C and on SS304 with a carbon content of 0.042% - 0.07% C. Welding for stainless steel material can be used on TIG welding to get maximum tensile strength values. For ASTM A36 steel materials, MIG welding can be an option.

1 Introduction

The welding process is joining two metals with base metal and the addition of filler. Permanent metal bonding is a strength. It is an economical and efficient method with various techniques used in fabrication. Steel and stainless steel are used in industries such as manufacturing. TIG is a welding process using non-consumable electrodes. The electrode does not melt so it needs additional filler metal in order to unite the two metals. The inert gas spent by the welding torch covers the field caused by thermal. The electrodes and weld metal in this process protect the metal from reaction with air and from environmental pollution. Inert gas is commonly used from Argon and Helium because it does not react with the environment and will become a protective layer. Gas Metal Arc Welding is the most commonly used type of welding with the welding parameters are significant in obtaining the

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quality of the welded joint with appropriate geometry, mechanical properties, and physical properties [1].

Carbon steel characteristics are appropriate for its carbon level which is considerably used in mechanical engineering components. It is categorized into low-carbon (mild) steel considerably used for heavy components, and medium carbon steel used for pressure components, gears, railways, and shafts. High-carbon steel is used for cutting tools, brackets, and the fabrication processes [2]. The technology progresses through to the industrial aspect quickly. Many industrial areas utilize Metal Inert Gas (MIG) welding for several occupations in steel construction, especially mild carbon steel. Metal Inert Gas welding procedure generates efficiency, mainly in welding results and quick time of process [3].

In general, steel material is used not in sheet form or pieces. But it is used by making it a shape so necessary a joining (welding) process is carried out to produce a product ready-to-use product. There are various types of welding available. So must be able to choose the right welding technique to obtain a product with good results. The problems that exist in welding stainless steel vary depending on the type of stainless steel to be welded. The purpose of this research is to determine the effect of welding methods on tensile strength, impact strength, Vickers microhardness and microstructure of SS304 material and SS316. Welding is carried out using TIG and MIG methods and test objects have a thickness of 2-3 mm. Next, testing is carried out which includes tests tensile, impact test, hardness test and microstructure test. TIG and MIG welding techniques affect each material, among others on the results of microstructure tests, hardness tests, tensile tests and impact tests [4].

Welded joints greatly influence the selection of welding current and seam with additives that match the base metal. The purpose of this research is to determine the effect of MIG welding strength on low-carbon steel on seam variations welding and welding electric current. Test results from variations in the electric current provided show that each weld seam requires a different current to produce good welded joints. Data from tensile testing using the ASTM E-8 standard produces stress values highest tensile strength in MIG welding using seam I with a current of 150 amperes amounting to 45.582 kg/mm2. The greater the current, the more visible the grain size and smoother in the weld metal area [5].

Mechanical properties evaluation on low-carbon steel using TIG welding showed that the ultimate tensile strength of the specimen increased along with the gas flow given to the specimen. This condition is also consistent with a decrease in tensile strength along with a decrease in the flow of gas. Specimen with the current 60 A and electrode filler rod 2 mm and gas flow rate (6 L/min) has created 424.31 MPa of the maximum tensile strength. The specimen with welding current 40 A and diameter of electrode 1.5 mm and a gas flow rate (5 L/min) has created a tensile strength of 356.10 MPa [6]. The TIG welding of Low-carbon Steel for LPG Car Tank Industry investigation and our main characterization techniques used are SEM (Scanning Electron Microscope), hardness testing, X-ray diffraction, and optical microscopy. This research reported that We have found a microstructural and mechanical difference between the welded joints. Based on our results, the following results were obtained. The Base Metal, Heat Affected Zone, and Fusion Zone were inspected in welded joints by the two processes. The area of the Fusion Zone in a specimen of welded joint by laser process is dissimilar from the FZ in the welded joint by TIG process. X-ray diffraction analysis claimed no formation of recent phases in the specimen of two welded joints. Hardness test results showed differences in microstructural between the three zones [7].

Research on low-carbon steel was carried out using welding Shield Metal Arc Welding (SMAW) with tensile and bending tests from various current (60 A, 70 A and 80 A) in order to know the strength of the welding of ST 37 steel in the paddock so as not to damage occurs when it used. The tensile test results prove that the current 80 A welding produces a structural stress average of 384.27 N/mm2 and thus is the ideal welding current. Strength tensile increases as the welding current increases at the range 60 A to 70 A and 80 A. According to empirical evidence, the basis of bending, current welding 80 A produces an average flexural strength of 1383.02 N/mm2, which is the ideal welding current. Bending strength increases with welding current increased from 60 A to 70 A and 80 A [8]. From several research results, this review study aims to determine the comparison of MIG and TIG welding on low-carbon steel against the results of the tensile test.

2 Method

This study review used a comparative quantitative method. Data 1 material used is SS 304 stainless steel with a diameter of 6 mm variation of welding current 80 A, 100 A, 120 A. Welding connection type (lap joint). There were three specimens in this study each variation of current [9]. Data 2 material used is ASTM A36 steel plate or carbon steel, with a plate thickness of 6mm.Variation of welding current is 150A, 155A, and 160A. Type flat welded joints (butt joints) and V seams with a 70º angle. There are three specimens for each current variation. Dimensions of the specimens used in the study it is based on the JIS Z 2201 1998 standard [10]. The steps in qualitative comparative research are:[11]

a. Research variables to be compared are TIG and MIG for low-carbon steel to tensile strength value. The problem formulation in this research is which tensile strength value is better using these two welding methods.
b. The aim of this research is to find a better welding method for two types of low-carbon steel compared to the tensile strength.
c. Create a research design
d. Research and analysis
e. Conclusion

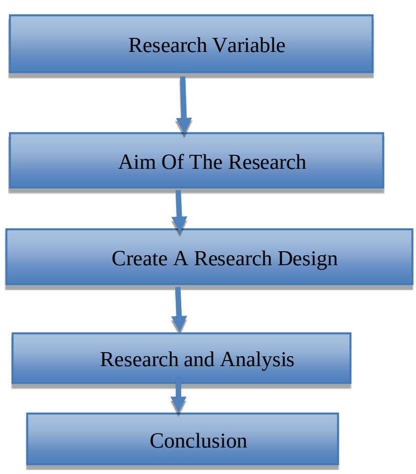

Fig. 1. The steps in qualitative comparative research.

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Table 1. Research variables (compare TIG and MIG for two types of low-carbon steel).

Specimen	Welding type	Current Variations (A)
SS304 content low-carbon cylinder	TIG	80, 100, 120
ASTM A36	MIG	150, 155, 160

3 Results and Discussion

Table 2. Tensile Strength for SS304 and ASTM A36.

Specimen and Welding Type	Current (A)	Tensile Strength (N/mm^2)
SS304 TIG	80	901.15
	100	1007.31
	120	938.89
ASTM A36 MIG	150	354.92 350.07
	155 160	350.07

Table 1 shows that tensile strength highest value obtained in the current variation of SS 304. Based on the diagram above, it can be seen that the average value of tensile strength at an electric current of 80 A is 901.15 MPa and at a current of 100 A, the resulting tensile strength 1007.31 MPa, an increase of 106.16 MPa from a current of 80 A. A current of 120 A, the resulting tensile strength 838.89 MPa, found an increase in current of 37.74 MPa from a current of 80 A and a decrease in current from a current of 100 A of 68.42 MPa. The increasing value can be shown in Figure 2 below:

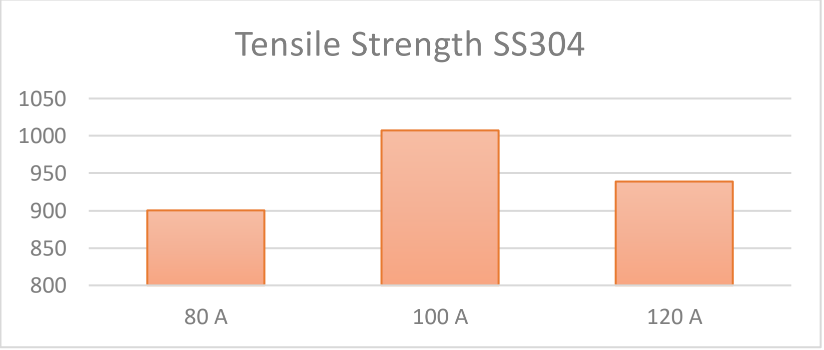

Fig. 2. Tensile strength material SS 304 with current variations.

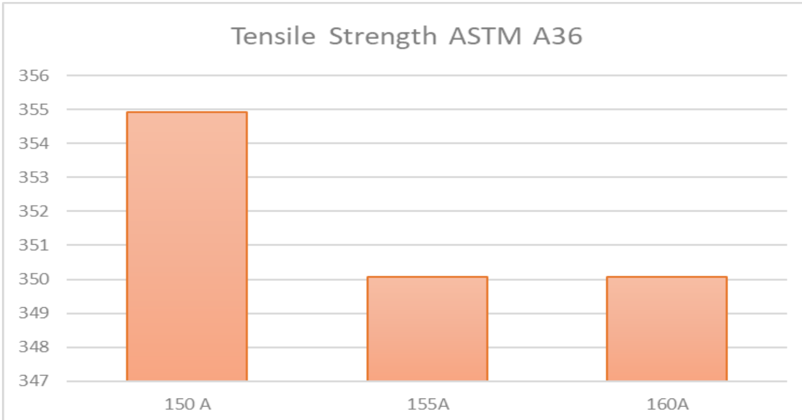

Fig. 3. Tensile strength material ASTM A36 with current variations.

The tensile test data shows that the yield stress table for a current of 150 A is 284.47 MPa. The yield strength current of 155 A has a decrease in current compared to this current. The yield stress figure for a current of 155 A is 279.32 MPa, there is a decrease in the current of 5.15 MPa from a current of 150 A. The yield strength table for an electric current of 160 A is 280.94 MPa, it is a decrease in yield strength of 3.53 MPa from an electric current of 150 A, and there is an increase to an electric current of 155 A of 1.62 MPa. Changes in tensile strength can be seen in Figure 3:

Table 3. Tensile Strength comparison for SS304 and ASTM A36

Specimen and Welding Type	**Tensile Strength (N/mm^2)**	**Results**
SS304 TIG	901.15	Above raw material[12]
	1007.31	Max above raw material
	938.89	Above raw material
ASTM A36 MIG	354.92	Max value (under raw material) Under raw material
	350.07 350.07	Under raw material[13]

Table 3 shows that using TIG welding for SS304 low-carbon steel does not require a high current value to get the maximum tensile strength value. However, ASTM A36 low-carbon steel requires a high welding current if using the MIG welding method to obtain tensile strength. However, the data shows that the maximum tensile strength value occurs in welding with the lowest current variations. The resulting tensile strength value is still below the tensile strength value of the raw material. Using the TIG welding method and a larger current produces a higher heat input during the welding process which results in a rapid cooling rate. Increasing welding current from 150 A to 155 A and 160 A results in a decrease in tensile strength. There is a decrease in tensile strength when there is an increase in welding current due to slow cooling speed [14, 15].

4 Conclusion

The result of tensile strength with the MIG process produces the highest average current of 150 A of 354.92MPa. The results of the tensile strength TIG process for 100A of 1007.31 MPa and the recommended minimum welding current for SS 304 stainless steel with a diameter of 6 mm is 100 A to obtain optimal results. The suggestion of this review is in MIG welding a greater current is required to obtain a high tensile strength value than the current required for TIG welding on low-carbon steel ASTM A 36 with a carbon content of 0.29% C and on SS304 with a carbon content of 0.042% - 0.07% C. Welding for stainless steel material can be used on TIG welding to get maximum tensile strength values. For ASTM A36 steel materials, MIG welding can be an option.

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