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ANALYSIS OF HARDNESS, CRYSTAL STRUCTURE, AND TENSILE STRENGTH BY TREATMENT WITH VARIATIONS OF WELDING CURRENT STRENGTH GTAW MATERIAL SS 316L

Melya Dyanasari Sebayang and Rizky Mahaendra Putra
Department of Mechanical Engineering, Universitas Kristen, Indonesia
E-Mail: melcan_sebayang@yahoo.co.id

ABSTRACT

This research occurred because problems arose, one of which was a leak in the tank from welding in the tank fabrication with the connecting material being Stainless Steel 316L. The welding process is very important to influence the results and function of the output product from this fabrication. There were leaks in 4 of the 8 tanks, namely at the welded joints. Variations in current strength in the welding machine are one of the factors that influence the welding results. In this study, we analyzed the welded joints with variations in current strength, including 60 A, 70 A, and 80 A. The analysis tests were tensile testing, hardness testing, and X-RD to find out what the deviation is for variations in current strength and to know the results of crystal structure and uniform current strength settings for maximum results and overcoming leakage problems.

Keywords: welding, GTAW, SS 316L, XRD, Crystal structure.

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1. INTRODUCTION

Welding is the process of joining several materials by heating them until they melt, with added materials or not. The material connected in this research is Stainless Steel 316L. The welding method used in welding stainless steel generally uses Gas Tungsten Arc Welding (GTAW). This welding process is generally used on steel materials. The nature of stainless steel, namely high alloy steel, makes the quality of the welded joint brittle because it is affected by the heat from the welding process. [1]. The characteristics of austenitic stainless steel are that it is a poor heat conductor and is also sensitive to thermal expansion during the welding process, both of which can cause irregularities and damage. These aspects also make GTAW (Gas Tungsten Arc Welding) welding an option for welding austenitic stainless steel because it creates a fairly minimal HAZ (heat affected zone). [2]. Molybdenum gives type 316 L greater strength against various forms of damage. [3]. Incorrect welding parameters on the material will result in poor mechanical properties resulting from the welding results, so the shape of the material will change, especially in the HAZ area. Type 316 L stainless steel is characterized by good weld strength because the welding process is a very important method in the manufacturing process. [3]

2. MATERIALS AND METHODS

The material used for research is SS 316 L material which is a material commonly used for basic tank shell products.

The research method can be described as the SS 316 L material being cut into six pieces of the same size, then the six pieces are welded in pairs into three types of specimens with different current variations of 60 A, 70 A, and 80 A in the welding. The three specimens were then subjected to 3 tests, namely the X-RD (X-Ray Diffraction) test, material hardness test, and material tensile test. Variations in the strength of different welding currents will affect the crystal structure, hardness value, and tensile strength. The material for the test specimen is an SS 316 L plate with a thickness of 3 mm.

Table-1. Identity of material test specimens.

No	Specimen	material grade	electric current	Specimen Dimension
1	Specimen of A	SS 316 L	60A,70A,80A	120 mm x 225mmx 3 mm
2	Specimen of B	SS 316 L	60A,70A,80A	120 mm x 225mmx 3 mm
3	Specimen of C	SS 316 L	60A,70A,80A	120 mm x 225mmx 3 mm

Before cutting the material, a cutting layout is made (cutting plan), then cut using a 4-inch grinding machine. After the material is cut, it goes into the material welding process and after that, the material is given an identity with different variations in current strength. The weld results are cut and taken in the middle, the cutting is done with a 4-inch grinding machine. The final cutting results are then tested on the specimen.

The test carried out in this research was crystal structure testing using X-ray diffraction. From this test, the results obtained were hardness value and tensile strength value, and from the crystal structure test, crystal size,

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dislocation density, micro strain, and yield strength were obtained. Then hardness testing using a hardness tester, tensile strength testing (tensile test) using the same equipment as a hardness tester but converted from the results of the Brinell hardness test.

3. ANALYSIS

Data and test results for crystal structure, hardness, and tensile strength were carried out using the respective test equipment. The results of the test will determine the value and the effect of variations in current strength on the quality of the material.

3.1 Crystal Structure Testing

Crystal structure testing was carried out using the X-ray diffraction (X-RD) test. From the X-RD testing of previously prepared material specimens, it can be determined whether the crystal structure influences the strength of the plate material that has been welded for the shell section of the basic tank.

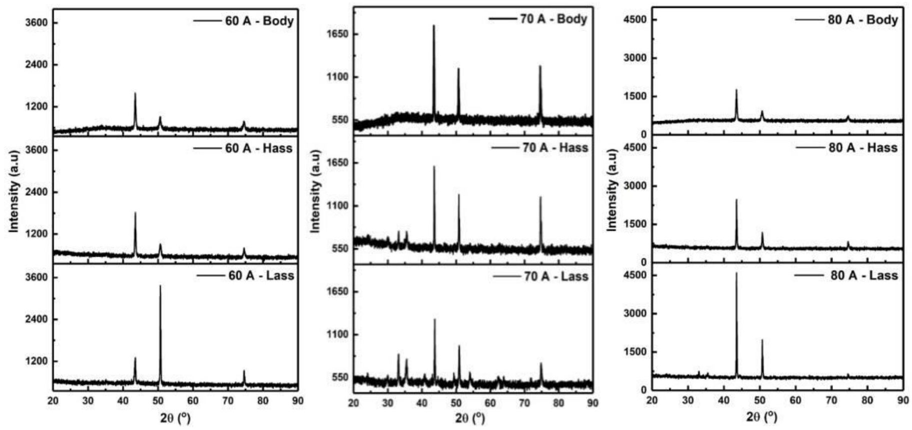
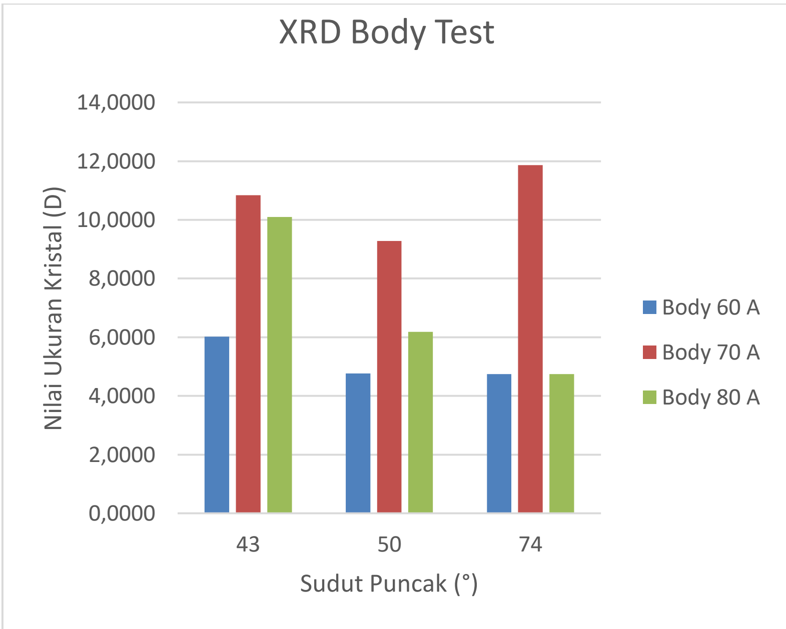


Figure-1. Intensity graph of X-RD results for 60 A, 70 A, and 80 A specimens.

Crystal structure testing produces 4 results which can be calculated using intensity graphs from the X-RD test results. From this graph, 3 different peaks are obtained, from which the values of these peaks can later be calculated. The values obtained are:

A. Crystal size (D Sample)



From this test, the crystal value can be seen from the highest peak angle which has the largest crystal size with moderate current strength, and the lower the peak angle and current strength, the smaller the crystal size value.

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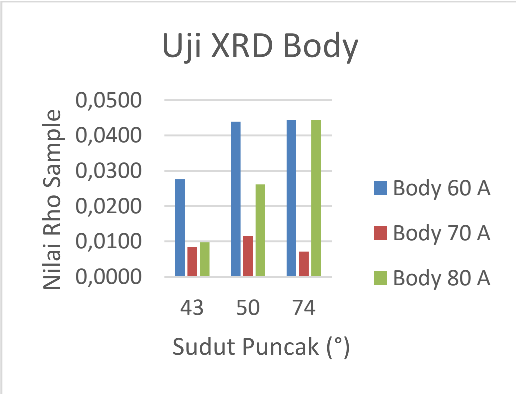
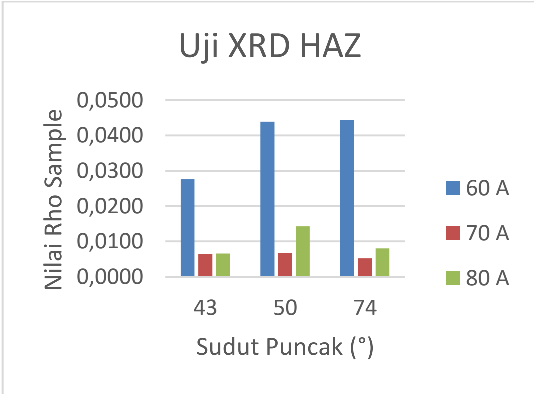
B. Dislocation density (Rho Sample)

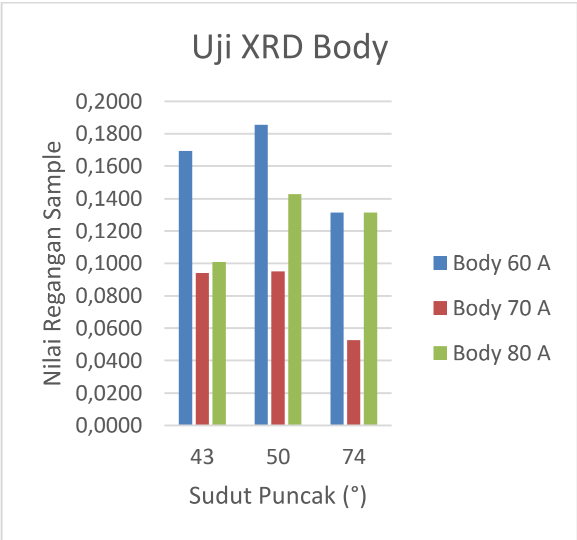


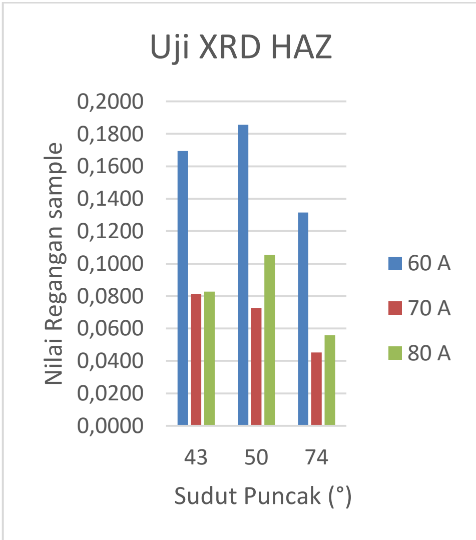


From this graph, the rho value can be seen from the lowest peak angle which has a low rho value with medium current strength, and the greater the peak angle with low current strength, the higher the rho value.

From this test, the rho value can be seen that the highest peak angle has the greatest rho value with the lowest current strength, and the lower the peak angle with the higher current strength, the lower the rho value.

C. Micro strain (Sample Strain)





From the results of the sample strain graph, it can be seen that the highest peak angle gets the lowest strain value with medium current strength, while the lowest strain value is not from the lowest peak angle with high current strength but rather from a peak angle of 50 ° with low current strength.

From the sample strain results, it can be seen that the highest peak angle gets the lowest strain value with medium current strength, while the lowest strain value is not from the lowest peak angle with high current strength but from an angle of 50° with low current strength.

3.2 Material Hardness Testing

Hardness testing was carried out on 3 specimens welded with different current strengths from the same material. The hardness values obtained are as follows:

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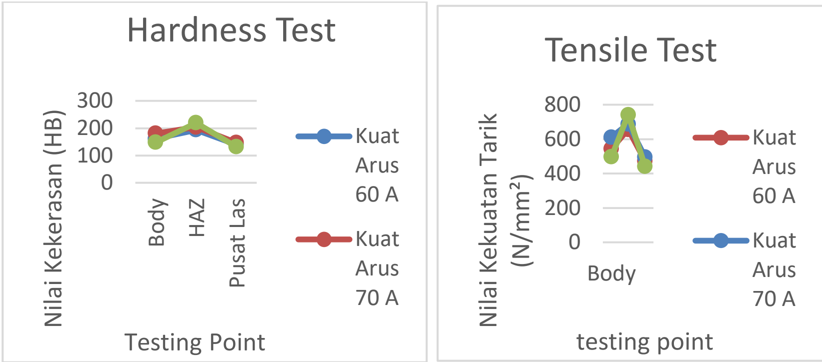

Figure-2. Graph of hardness values.

Hardness testing using a hardness tester on 316 L stainless steel material with a welding process of 3 different current strength variations produces several different variables. The highest strength is located at the HAZ test point with the highest current strength. The change in value is caused by the material experiencing changes in its microstructure which results in changes in the characteristics of the material and also a decrease in the hardness value. Because welding causes deformation in the material, variations in current strength cause differences in material hardness values.

3.3 Material Tensile Strength Testing

Tensile strength testing was carried out on 3 specimens welded with different current strengths from the same material. The hardness values obtained are as follows:

Tensile strength testing using a hardness tester whose values are converted from the Brinell scale to tensile strength on 316 L stainless steel material with a welding process of 3 different current strength variations produces several different variables. The highest power is located at the HAZ test point with the highest current strength. The change in value is caused by the material experiencing a change in microstructure which results in changes in material characteristics and also a decrease in the tensile strength value. Because welding causes deformation in the material, variations in current strength cause differences in material hardness values.

4. CONCLUSIONS

This research was conducted to determine the effect of variations in current strength on welding during the tank fabrication process, namely the welding process. The conclusion of this final assignment is:

a) The effect of variations in current strength in plate welding on the crystal structure is that it causes different crystal sizes, different dislocation densities, different microstrains, and different yield strengths, but the difference values are very small and have little effect on the quality of the material.

b) The effect of variations in current strength during welding on material hardness on the Brinell scale is that the hardness value increases after the material undergoes the welding process, the material experiences changes in microstructure which results in changes in the characteristics of the material and also an increase in the hardness value. Of the three specimens tested at the center position of the weld, it had the highest hardness after welding with a current strength of 70 A. So from the material hardness, a current strength of 70 A is the best current strength for the tank welding process with SS 316 l material with a plate thickness of 3 mm.

c) The effect of variations in current strength during welding on the tensile strength of the material, namely that the tensile strength value decreases after the material undergoes the welding process, and the material experiences changes in microstructure which results in changes in the characteristics of the material and also a decrease in the tensile strength value. Of the three specimens tested at the center position of the weld, it had the highest hardness after welding with a current strength of 70 A. So from the material hardness, a current strength of 70 A is the best current strength for the tank welding process with SS 316 L material with a plate thickness of 3 mm.

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