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THE EFFECT OF CURRENT VARIATION ON MICRO STRUCTURE AND HARDNESS IN ALLOYSTEEL SS400 WELDING PROCESS USING SMAW METHOD

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KEYWORDS

Shielded Metal Arc Welding (SMAW)
Microstructure
Hardness

ABSTRACT

This research aims to find out the effect of current on microstructure and hardness value in Alloy Steel SS400 before (raw material) and after welding using Shielded Metal Arc Welding (SMAW). This research uses experiment methods. Technique of analyzing data used was a descriptive comparative research. The instruments used for testing microstructure and hardness were Olympus Metallurgical Microscope and Vikers Hardness Tester. Base on the result of research, it could be concluded that the result of microstructure testing showed the improved ferrite structure after welding. In raw material, ferrite structure seemed to looks evenly, but the result of welding using SMAW welding method with current of I20 A, 130 A, and 140A showed that ferrite structure reduced in each specimen, so that perlite structure was very dominant. The hardness value of hardness result showed the different hardness level. The specimen with current of 140 A had higher hardness level of 231,055 VHN than the specimen with current of 120 A (219.222 VHN) and 130 A (223,333 VHN). The result of hardness testing on raw material was 182,333 VHN. This research showed that the welding using varying current changed microstructure and affected the hardness value of Alloy Steel SS400.

INTRODUCTION

Metal joints with welding methods are increasingly being used, both in building and machine construction. According Cary (1998), the extent of the use of welding joints processes is caused by low costs, the implementation of relatively faster, easier, and more varied forms of construction. However, it must be admitted that welded joints also have disadvantages, among others: the large voltage surges due to changes of microstructure in weld area causes the material come strenght down, and cracking due to the welding process (Jamasri, 1999). According to Wiryosumarto (2000), not all metals have good weldability. One of materials has good weldability is low carbon steel. The Steel can be welded by arc welding with wrapped electrodes. Low carbon steel is commonly used for thin plate and general construction. In welding, freezing of the weld rate is not simultaneous consequently residual stress arises especially the HAZ (Heat Affected Zone) and weld areas.

The lower carbon alloy steel is widely used for general construction because it has weldability and sensitivity to weld cracks. Low crack sensitivity is suitable for the welding process, and can be used for welding thin plates or thick plates. the weld quality is better than the parent metal. SS400 steel is generally described as low carbon steel, also called soft steel, widely used for the manufacture of steel bars, tanks, shipping, bridges, towers, lift aircraft and in machinery. In the construction design, many involve welding elements with welded joints as an alternative to connecting certain parts.

Technically making welded joints requires high skill for the welders to obtain good quality connections. One of the deformed welded joints will eventually cause damage to the other joints and finally the construction can collapse which causes material losses that are not small and even fatal. Good welding quality of course requires an appropriate welding method. One of them is the welding method of SMAW (Shielded Metal Arc Welding) (Subardi, 2009).

In welding, SMAW electrodes have an important role as a connecting material between two metals to be welded and these electrodes consist of many sizes, types and are sold in a variety of brands. In order to get good welding results, the electrodes used must be adjusted to the material to be welded and the selection of the appropriate welding parameter parameters will also improve the quality of the welding results. This welding uses E7018 electrode with a diameter of 3.2 mm, then the current used ranges from 115-165 Amper. With these current intervals, the welding produced will be different (Soetardjo, 1997).

Adjusting the welding current will affect the weld. If the current used is too low it will cause difficulty in igniting an electric arc. The electric arc that occurs becomes unstable. The heat that occurs is not enough to melt the electrodes and the base material, so the result is a small and uneven weld rigi and less penetration. Conversely, if the current is too high, the electrode will melt too quickly and will result in a wider weld surface and deep penetration resulting in low tensile strength and increasing fragility from the welding results (Arifin, 1997).

To determine the effect of strong variations in the current on the hardness and microstructure of SS400 alloy steel, plate-shaped specimens were designed with a seam of welding V (Shielded Metal Arc Welding) (SMAW). In this study the variations used were current strengths of 120 A, 130 A and 140 A.

RESEARCH METHODS

This research method uses the experimental method. Experimental research carried out in the laboratory with the conditions and equipment completed in order to obtain data to study physical and mechanical characteristics of the results of welding. The material used is SS400 Steel Alloy. The material will be welded with a current variation of 120A, 130A, 140A using the welding method Shielded Metal Arc Welding (SMAW).

The process of welding specimens was carried out at the Las INLASTEK Laboratory and for microstructure testing and hardness of test specimens was carried out at the Technical Materials Laboratory Program, Department of Mechanical and Industrial Engineering, Faculty of Engineering, Gadjah Mada University, Yogyakarta.

Tests carried out include metallographic (microstructure) and hardness tests. The test equipment used in this study was the Olympus Metallurgical Microcope machine, the Vickers Micro Hardness Tester machine. In the hardness of welding results with a certain current strength, the area tested is the weld area, the HAZ region, the base material area.

The specimens used in this study amounted to 4 pieces, 3 results of welding specimens and 1 material without welding. The size of each specimen is 80 mm x 30 mm x 12 mm. The welded connection uses seam V and the type of welding uses SMAW welding (Shielded Metal Arc Welding).

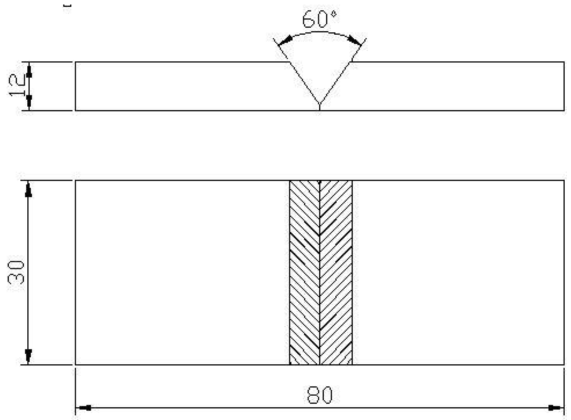
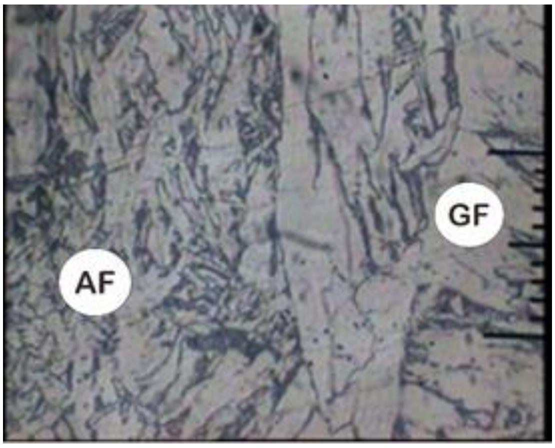


Figure 1. Dimensions of weld specimens.

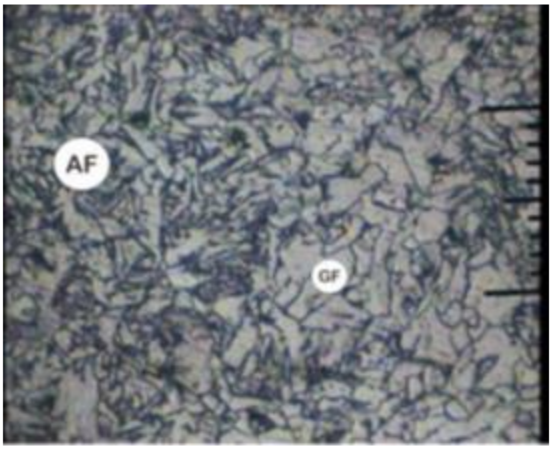
The data analysis technique used in this study is an analysis with a comparative descriptive method. The data obtained in this study were in the form of hardness data, and microstructure as well as from observations then analyzed descriptively.

RESULTS AND DISCUSSION

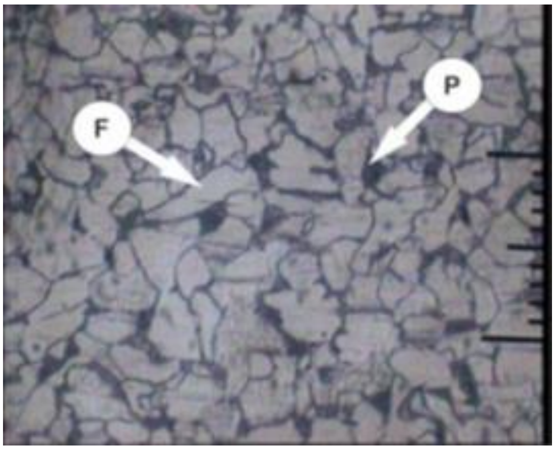
In this study microstructure testing aims to determine the microstructure of the SMAW welding test specimens.



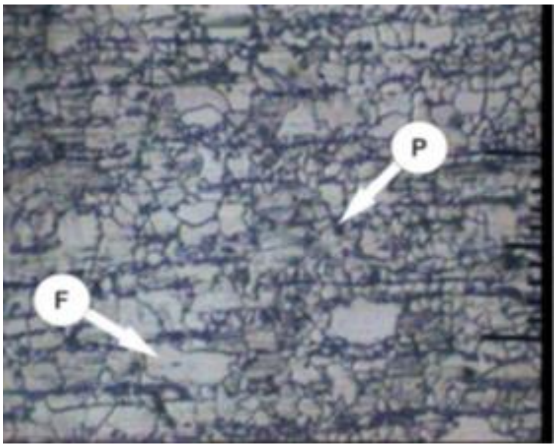
1. The welding area



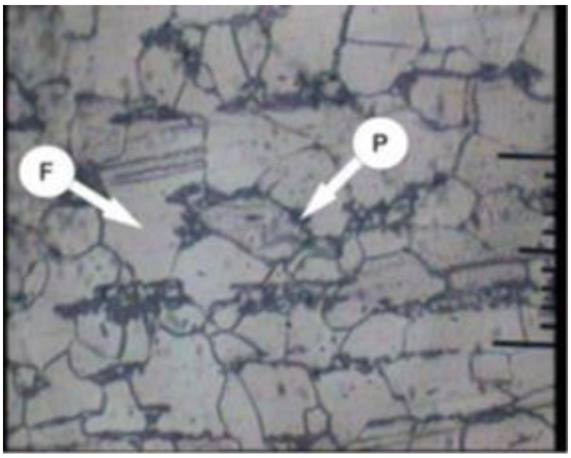
2. The HAZ of welding



3. HAZ



4. The main of HAZ



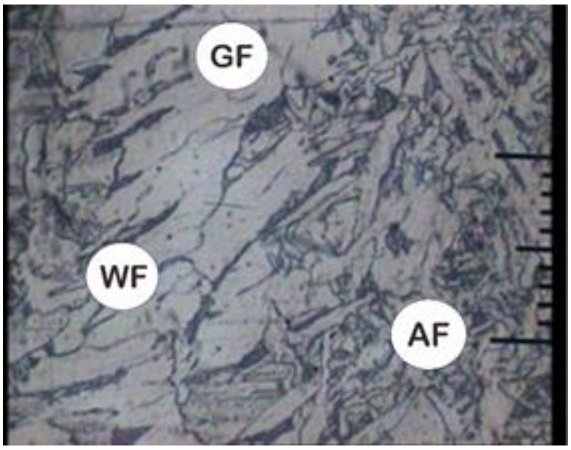
5. The main of metal

Figure 2. Microstructure of current 120 A

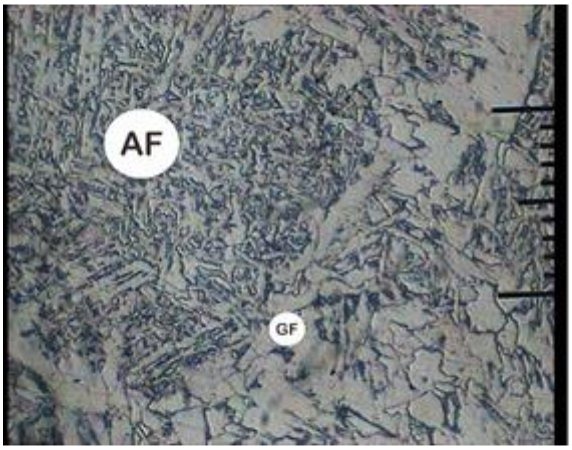
From figure 2. above shows the results of microstructure test on weld metal, weld metal boundary with HAZ, HAZ region, HAZ boundary with parent metal and parent metal with 120 A. current strength In weld metal shows acicular (AF) and ferrite microstructure grain boundary ferrite (GF). In the figure, the photos of microstructure for grain boundary ferrite are large and the structure for acicular ferrite is soft grained and dominates the area.

The weld metal boundary area with HAZ shows acicular ferrite (AF) and grain boundary ferrite (GF) microstructure. In the figure the microstructure image for acicular ferrite looks small and the structure for grain boundary ferrite looks large.

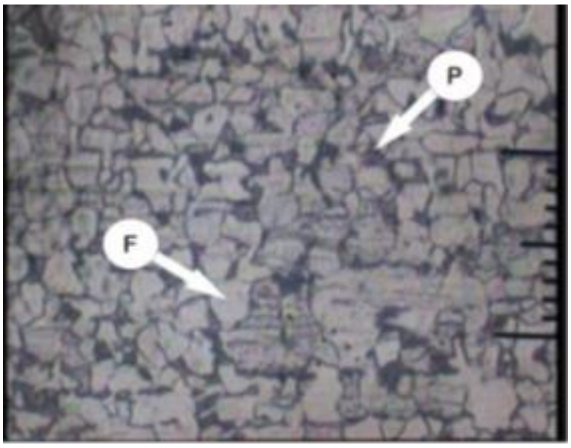
In the HAZ region, the HAZ boundary is weld metal, and the parent metal shows ferrite and pearlite micro structures. In the picture the microstructure photo for pearlite is quite dominating the area and the structure for ferrite looks small.



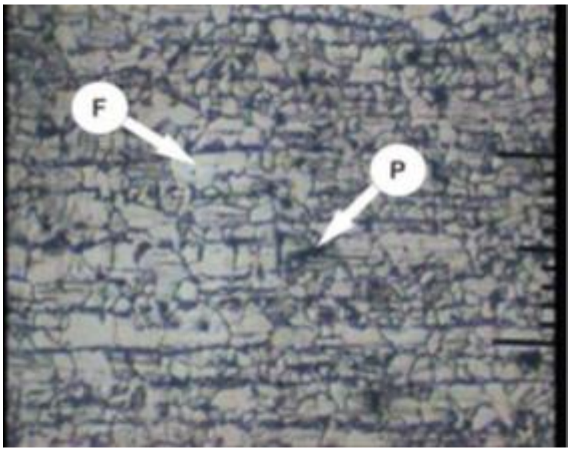
1. The welding area



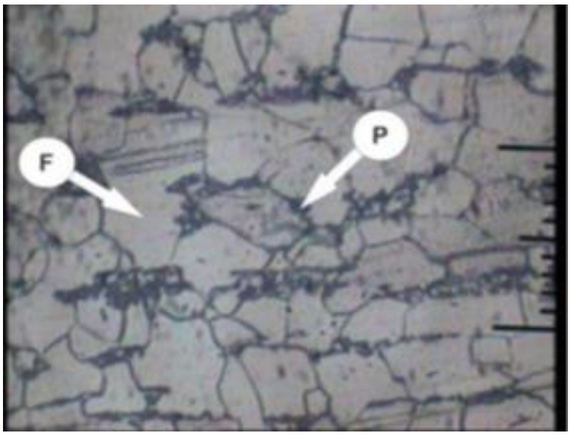
2. The HAZ of welding



3. HAZ



4. The main of HAZ



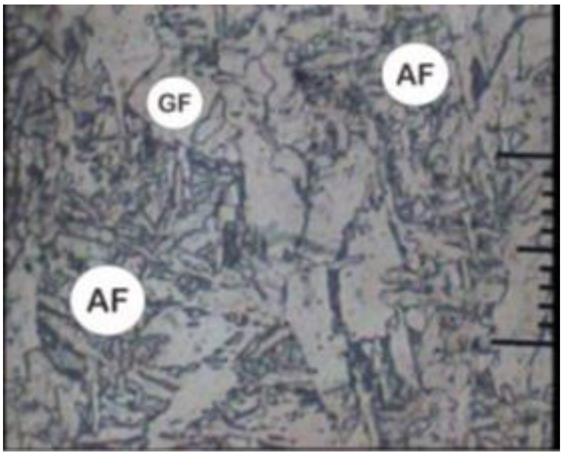
5. The main of metal

Figure 3. Microstructure of Current 130 A

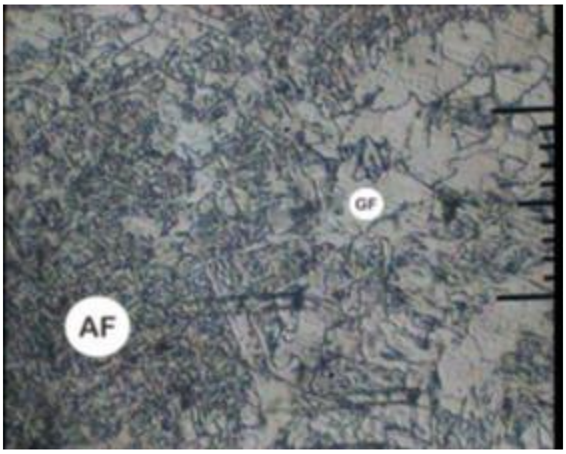
In Figure 3 above shows the results of microstructure test on weld metal, weld metal boundary with HAZ, HAZ region, HAZ boundary with parent metal and parent metal with 130 A. current strength In weld metal shows acicular ferrite (AF) microstructure, boundary ferrite Grain and Widmanstatten (WF) grain boundary ferrite (GF). In the figure the microstructure for grain boundary ferrite looks smaller when compared to 120 A currents and the structure for acicular ferrite (AF) still dominates the area. Widmanstatten's ferrite amount (WF) in the image is quite large and is found along the grain boundary line. This resulted in an increase in hardness in the weld metal area when compared to 120 A. current specimens.

The weld metal boundary area with HAZ shows acicular ferrite (AF) and grain boundary ferrite (GF) microstructure. In the figure the microstructure for acicular ferrite (AF) looks smoother than 120 A Flow and the structure for grain boundary ferrite (GF) still dominates the area.

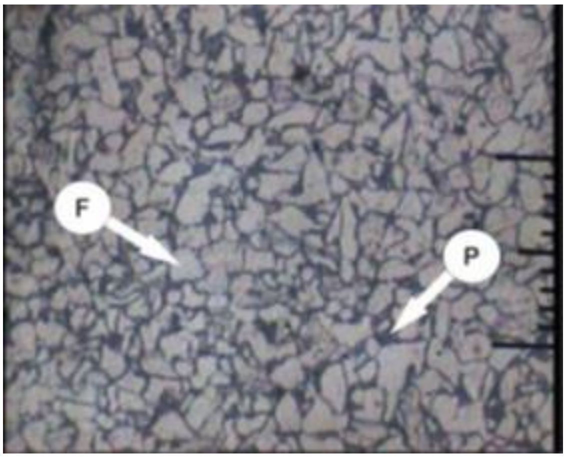
In the HAZ region, the HAZ boundary with the parent metal, and the parent metal shows ferrite and pearlite micro structures. In the picture, the microstructure for ferrite is less than at 120 A and the structure for pearlite appears to dominate the area. This results in the HAZ region, the HAZ boundary with the parent metal, and the parent metal harder than the 120 A. current specimen.



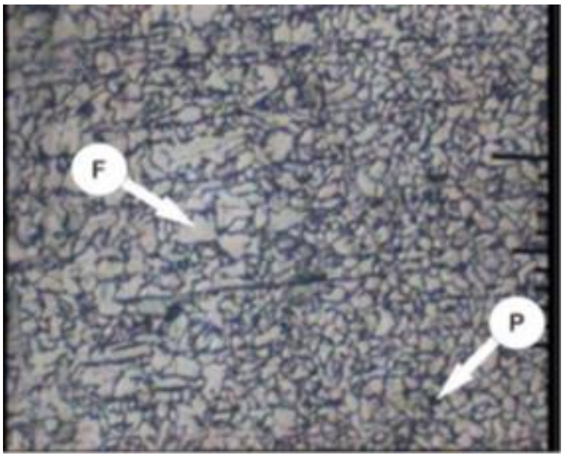
1. The welding area



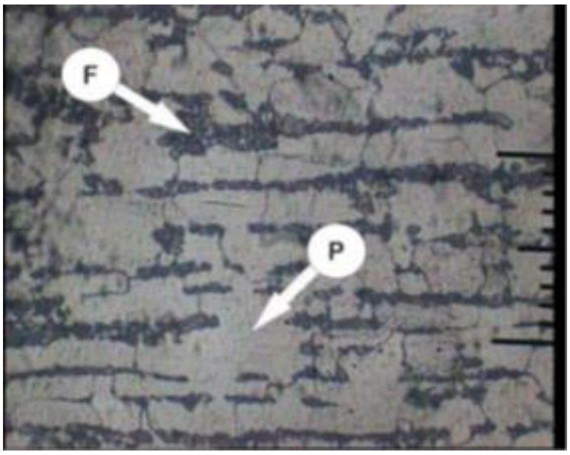
2. The HAZ of welding



3. HAZ



4. The main of HAZ



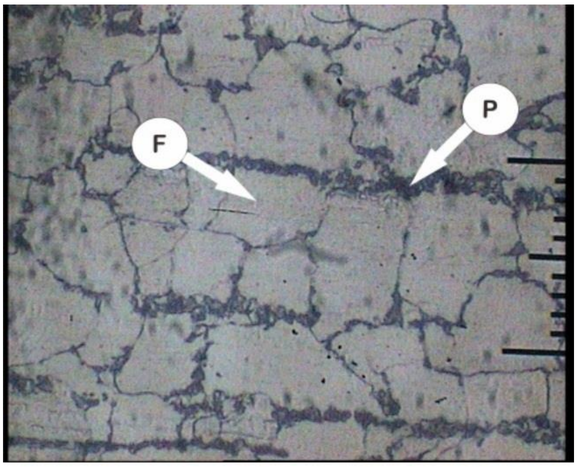
5. The main of metal

Figure 4. Microstructure Flow 140 A

In Figure 4 above shows the results of microstructure test on weld metal, weld metal boundary with HAZ, HAZ region, HAZ boundary with parent metal and parent metal with a current strength of 140 A. In weld metal shows the structure of acicular ferrite (AF) and boundary ferrite grain boundary ferrite (GF). In the figure the microstructure image for grain boundary ferrite is small and the structure for soft grained acicular ferrite dominates the area when compared with 120 A and 130 A. It is in accordance with the study (Rananggono, 2010) "If the current used is high, then the granules formed become smooth, on the contrary if the current used is small then the grain becomes large".

The weld metal boundary area with HAZ shows the acicular and grain boundary ferrite (GF) microstructure. In this picture the microstructure image for grain boundary ferrite is small and the structure for soft grained acicular ferrite dominates the area when compared to 120 Ampere and 130 Ampere currents.

In the HAZ region, the HAZ boundary with the parent metal, and the parent metal shows ferrite and pearlite micro structures. In the figure, the structure photos for ferrite appear smaller and the pearlite microstructure dominates the area more than in 120 A and 130 A. Currents.



Raw Material

Figure 5. Micro Structure of Raw Material

In Figure 5 shows the results of the microstructure of raw material (without welding). Visible ferrite structure is slightly more even when compared to base material, consequently material without welding tends to be slightly softer than base material.

The highest hardness value is found in the weld metal area with a current of 140 A which is 272 VHN. Whereas in the weld area with 130 A current strength of 256 VHN and 120 A current strength of 248,333 VHN. This is in accordance with the research (Santoso, 2006) "If the electric current given is greater, then the heat input (Heat

Input) given to the specimen will be even greater. In small electric currents, the hardness value of the specimen will tend to be lower and inversely proportional if the electric current used in welding is getting bigger ".

The weld area in the three specimens tended to be harder when compared to HAZ and the parent metal. Based on the observation of the microstructure, the weld area in the current 140 A tends to have more acicular ferrite compared to the weld area at 120 A and 130 A. The structure is the most effective structure in holding the load so that the area becomes harder. The smaller value of violence from the center of weld is also in accordance with the Easterling statement (1983) which states that the value of violence tends to decrease from the melting limit to the base metal depending on grain size (micro structure). This is because the farther away from the center of the weld, the effect of heat will decrease.

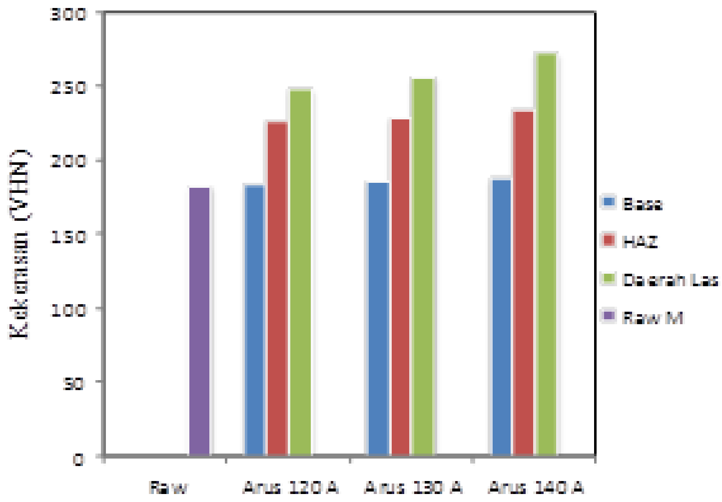


Figure 6. Graph of the Vickers Hardness Test Average Value

Hardness test results of specimens without welding (raw material) with a hardness of 182,333 VHN. When compared with the three welding specimens using different current strengths, the level of hardness in raw material tends to be lower. This result is in accordance with the research (Ahmad Soleh, 2016) which states that the higher the welding current, the higher the value of the hardness. Increasing the value of hardness in welding specimens is due to changes in microstructure, namely increasing the structure of pearlite.

CONCLUSION

Based on the results of the study, conclusions can be drawn as follows : 1) There is a strong influence on the microstructure of the welding results of SS400 alloy steel with a strong current of 120 A, 130 A and 140 A. In the HAZ area slow cooling occurs so that the grain in the micro structure will be enlarged, while in the acicular ferrite welding area is the most dominant weld results with a current of 140 A. 2) There is a strong influence on the level of hardness of the welding results of SS400 alloy steel with a current strength of 120 A, 130 A and 140 A. Specimens with a current strength of 140 A have a higher average hardness level of 231,055 VHN when compared to 120 A current strength specimens amounting to 219,222 VHN and 130 A amounting to 223,333 VHN. The hardness test results without specimens (raw material) amounted to 182,333 VHN.

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