

The Effect of Welding Pre Heating of SMAW and GTAW on Mechanical Properties of SA .106 Gr. B Pipe of Energi Sengkang Co.Ltd

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Abstract—This research aimed to analyze the differences in mechanical properties, such as tensile strength and hardness of the materials of SA.106 Gr B, experiencing SMAW and GTAW welding with preheat treatment. The research activities were conducted in the Laboratory of Materials Science of the Department of Mechanical Engineering, Faculty of Engineering, Indonesia Christian University of Paulus, Makassar. The material Preheating was done in the workshop of PT. Energi Sengkang. The method used was to create a specimen of the SA.106 Gr.B material experiencing the SMAW and GTAW welding with the preheat condition of 0°C, 110°C and 125°C. In order to determine the strength of the material, the mechanical test, i.e. the tensile test (ASTM E 8M), Hardness test (Brinell), and microstructure observation were done. The research results indicated that preheat process had an influence on the mechanical properties of the material before welding. In the process of SMAW and GTAW welding, the increase of preheat temperature had an impact on the increase of the value of the tensile test of preheat temperature of 125°C. In the GTAW welding, it was found that $\sigma_u = 54.51 \text{ kgf/mm}^2$, while in SMAW welding, it was found that $\sigma_u = 53.26 \text{ kgf/mm}^2$. In hardness test, it was found that the increase of the preheat temperature had an effect on the hardness in the welding area was 43.22 HB while in the GTAW welding it was 43.32 HB.

Keywords: preheat, SMAW, GTAW

I. INTRODUCTION

Welding is the process of switching metallic or non-metallic performed by heating the material which combined to a temperature welding is performed with or without using pressure, with pressure or not with charger (filter). Conventional Welding divided into working groups, namely by way of welding : Liquid welding, press welding, solder welding and by source of energy used : Chemistry welding, electrical welding for example SMAW and GMAW, SMAW welding (Shilel metal Arc Welding) or arc welding electrodes encased often called Electrical Welding. SMAW welding is the process of switching two metallic similar or more by using an electric heat source using electrodes that will make a fixed connection.

The Working principle is the current SMAW welding electrode tip is brought near the work piece heat is electric (arc)

is made between the work piece with the electrode tip covered melt simultaneously. According to AWS (American Welding society) principle from SMAW is using heat from the arc to melt the base metals and the end of a consumable electrode covered with a voltage of electricity used 23-45 used, for melting up to 500 amperes of electric current that is commonly used ranged from 80-200 ampere. In the SMAW process of oxidation can occur, this need to be prevented due to the oxidation of metal is a compound that does not have the mechanical strength. As to prevent that the material is protected with a layer enhancer welding protective substance called flux or slag which participated melt when welding. However, the density is lighter than metal melted, the liquid flux will float in the liquid metal, and isolate the metal so that it does not oxidize with the outside air. When frozen, the flux will also freeze and still protect the metal from oxidation. The series begins with a power source and cables including welding, electrode holders, connection of the work piece, the work piece (well-meant), and welding electrodes. Advantages of arc welding processes SMAW is the simplest and most versatile, because it is simple and easy to transport tools and equipment to make this SMAW process has broad application, Las SMAW can be done at various positions or locations that can be reached with a piece of electrode.

Location of weld joints with limited eyesight area can still be welded by means of bending the electrode. SMAW welding is used for welding a wide range of ferrous metals. Disadvantages SMAW rate Charging more low than the process of welding semi-automatic, Long electrodes differences despite welding Stop ON welding SMAW taxable income Sycamore electrode Burned Out electrode The wasted Remaining And Time Also wasted to review replace the electrode, slag OR crust Yang formed must be removed from the skin thick layer of thick layers of weld skin BEFORE the next, Singer Steps Up Reduce welding coefficient Approximately 50%.

Preheat or pre-heating is done to prevent the occurrence of weld cracks, eliminating residual stress (residual stress), increased toughness and control of the metallurgical properties in the HAZ (Heat Affected Zone). Preheating can be done with gas-Oksy flame, forging kitchen and oven. Preheating

temperature is determined by the carbon content of the parent metal and has developed a tool to measure temperature first heating by Lincoln Electric. Welding methods can also affect the quality of the weld. The method used must be in accordance with the needs of the construction. One method is welding Gas Tungsten Arc Welding (GTAW) or also called Tungsten Inert Gas (TIG). Welding is commonly used to connect carbon steel, stainless steel, copper and aluminum.

According Sudibyo and Purboputro (2013: 42), using the GTAW welding used to weld stainless steel. This is due to tungsten gas will displace the oxygen that would cause the metal oxide that results are very loud. This is due to tungsten gas will displace the oxygen that would cause the metal oxide that results are very loud. With GTAW, the metal oxide formation can be avoided. Metal welding methods which include welding procedures, heat treatment procedures, joint design and welding techniques adapted to the type of material, equipment and welding position when welding connection is made. Aspects of effectiveness, process efficiency, and economic considerations are closely related to the selection of welding equipment. Metal welding to connect materials of carbon steel, stainless steel, copper and aluminum will be good quality when using GTAW welding.

II. EXPERIMENT

Material The material used in this study is the carbon steel pipe steel (SA-106 GR.B) Outside shaped pipes with a diameter of 3.5 inch and Nominal Sch-80S. Materials cut using saws and grinding to form a V seam connection using Standard ASTM E 8M. Material before welded using GTAW and SMAW welding in hot beriperlakuan beginning first with the flame oksy-gas temperature 110°C and 125°C. Material that has been welded and then do day penetrant tested for surface defects of material that has been welded. Material that has been welded and then cut using saws and milling to form the test specimen according to standard ASTM E 8M.

The specimens used in this study, based on the following table:

Table 2.1 Sample testing for SMAW

No	Temperature preheat	Type Electrode	Tensile Test	Harnes	Mocro Structure
1	0°	E7018	3	1	1
2	110°	E7018	3	1	1
3	125°	E7018	3	1	1
Total Sample			9	3	3

Table 2.2 Sample testing for GTAW

No	Temperature preheat	Type Electrode	Tensile Test	Harnes	Mocro Structure
1	0°	ER-TG-S50	3	1	1
2	110°	ER-TG-S50	3	1	1
3	125°	ER-TG-S50	3	1	1
Total Sample			9	3	3

Tensile test specimens refers to the size of the specimen square berpenampang using the standard ASTM E 8M. Based on these standards, the material forms a test for tensile testing must be adapted to the testing standards as shown below :

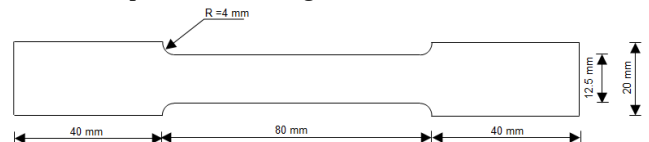


Figure . 2.1 Size of specimens tensile test standard ASTM E 8M

Materials for hardness tests made in accordance with ASTM E18. Indenter in hardness test uses steel balls as Brinell with emphasis indenter. Test of the violence done to determine the hardness distribution in each region of the parent metal, HAZ and weld metal of the weld and heat treatment, as in the picture:

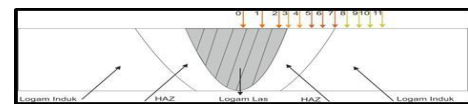


Figure 2.2 Schematic hardness test specimen area

III. RESULT AND DISCUSSION

3.1 Analysis Testing of Tensile

Based on calculations that have been done, graphically results preheat treatment of SMAW welding is known as the graph in Figure 3.1. In the condition known that the process of increase the maximum preheat temperature result in increased tensile strength test specimens. On specimens without preheat treatment, known maximum tensile strength (σ_u) = 47.57 kgf/mm², the specimen preheat 110°C maximum strength of 49.02 kgf/mm² and at 125 °C preheat obtained the maximum strength of 53.26 kgf/mm².

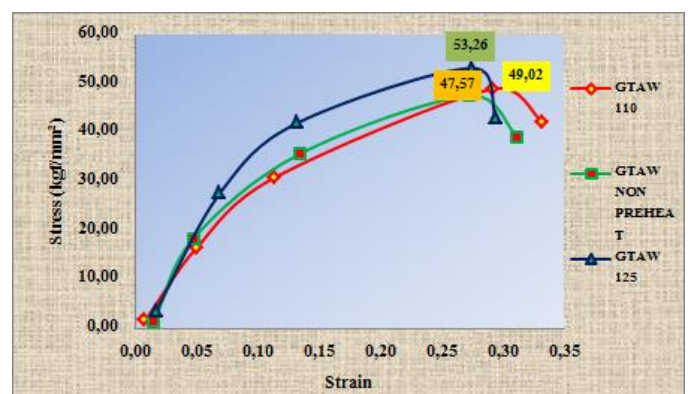


Figure 3.1 Graph of relationship tension (σ) and strain (ϵ) in SMAW welding.

In GTAW welding similar conditions showed that the preheat process resulted in the increased value of the tensile strength of the material. as in Figure 3.2 below.

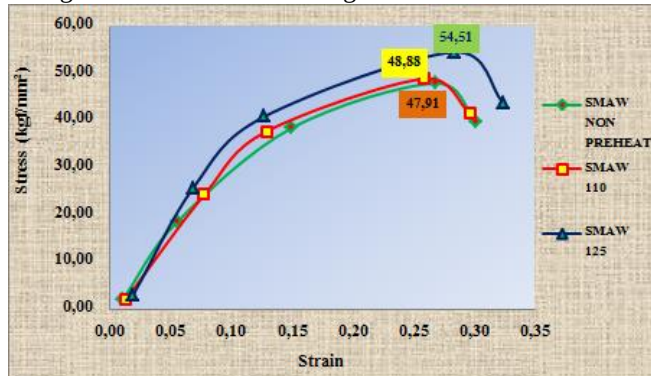


Figure 3.2 Graph of relationship tension (σ) and strain (ϵ) in GTAW welding.

On specimens without preheat treatment of maximum strength (σ_u) amounted to 47.91 kgf/mm², the specimens with preheat treatment of 110°C σ_u = 48.88 kgf/mm² and the specimen with the treatment of 125°C σ_u = 54.51 kgf/mm². The second graph in Figure 3.1 and 3.2 show that the process of preheat 125°C give maximum effect to the tensile strength.

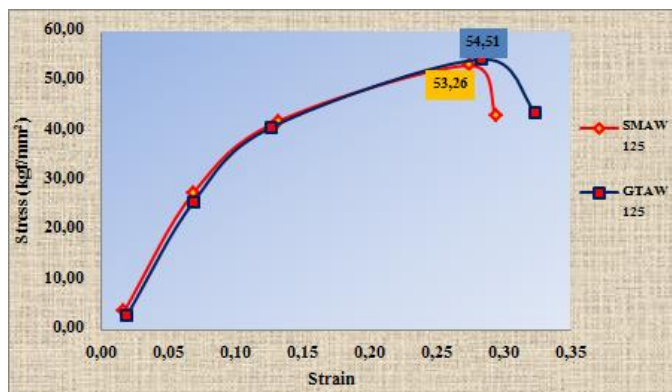


Figure 3.3 Graph of relationship tension (σ) and strain (ϵ) on GTAW and SMAW welding the preheat process 125 °C

On a graph of voltage by using GTAW welding strain has the highest strength of 54.51 kgf/mm² whereas the SMAW welding of 53.26 kgf/mm².

3.2. Analysis Testing of violence (hardnes Test)

3.2.1 Welding SMAW

From the test data, it is known there are key positions, such as Filler Metal, HAZ and Raw Materials as in Table 3.1 below.

Table 3.1 Data from testing hardness by Brinell (BHN)

NO	TREATMENT	POSITION OF EMPHASIS											
		0	1	2	3	4	5	6	7	8	9	10	11
1	SMAW NON PREHEAT	43.12	43.07	42.81	41.59	41.15	38.65	38.27	38.19	32.34	32.13	32.22	32.25
2	SMAW 110	43.22	43.13	43.06	40.75	41.00	38.11	37.87	37.52	31.87	31.91	31.68	31.73
3	SMAW 125	43.07	43.13	43.03	39.55	40.00	38.10	38.12	37.43	31.17	31.24	31.22	31.21
CONDITION		FILLER METAL			HAZ					RAW MATERIAL			

Under the conditions of the test results table with 12 times the emphasis each specimen decreased hardness can be illustrated in the graph in Figure 3.3 below:

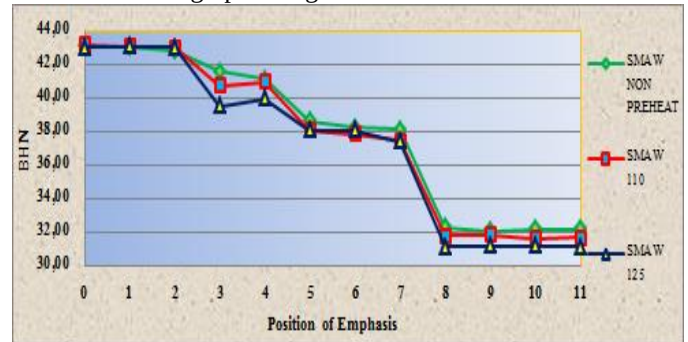


Figure 3.3 Graph of relationship tension (σ), hardness (BHN) to the position of an emphasis on welding SMAW.

3.2.2 Welding GTAW

In GTAW welding preheat effect also impacts on the declining value of the material hardness in the weld metal, the HAZ area, while the value of hardness in the raw material tends to remain, as in the following tabel.

Table 3.2 Data from testing hardness by Brinell (BHN).

NO	TREATMENT	POSITION OF EMPHASIS											
		0	1	2	3	4	5	6	7	8	9	10	11
1	GTAW NON PREHEAT	43.00	43.12	42.81	41.59	41.15	39.11	38.65	38.71	32.24	32.18	32.20	32.13
2	GTAW 110	42.49	42.89	42.79	41.44	41.18	38.54	38.28	37.52	32.08	32.14	32.00	32.11
3	GTAW 125	43.32	43.15	42.55	40.97	41.21	39.10	38.10	38.22	32.16	32.12	32.18	32.15
CONDITION		FILLER METAL			HAZ					RAW MATERIAL			

Based on the graphical table 3.2 can be described as follows:

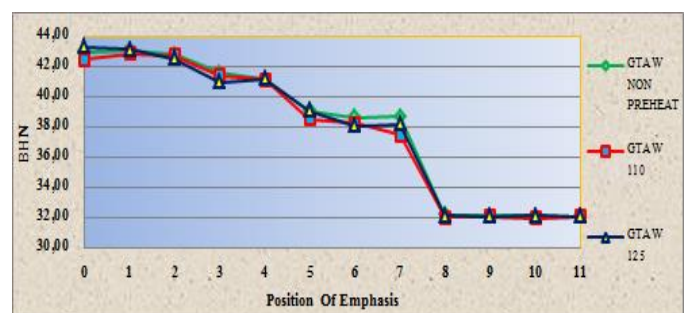


Figure 3.3 Graph of relationship tension (σ), hardness (BNH) to the position of an emphasis on welding GTAW

In both SMAW and GTAW welding process both decreased in terms of violence. The condition is caused by a slow cooling rate. The higher the temperature treatment is given, then the cooling process will be slower.

3.3. Analysis of Micro Structure

Based on observations on the microstructure known process changes that occur as a result of the welding preheat treatment SMAW is as follows.

By observe microstructure strength increase of the tensile strength and a decrease in the level of violence caused by the change in microstructure.

In SMAW welding between the specimen without preheat the specimens preheat 125 °C as follows.

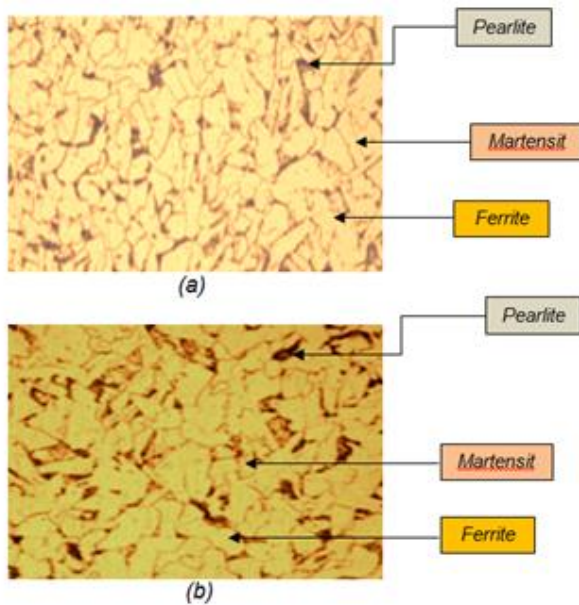


Figure 3.5 a.Composition of micro structure on SMAW welding and Non Preheat with magnification 300X, b.Composition of micro structure on SMAW welding and Preheat 125 °C with magnification 300X,

From the results of the above observations (Fig 3.5), it appears that the composition of the ferrite on specimens without preheat treatment more and distributed in the appeal at 125°C fewer specimens Preheat these conditions allows the hardness value decreases or lower at a higher preheat temperature. The condition is also greatly influenced by the amount of pearlite is more dominant with larger grains at 125°C preheat treatment, in which the ferrite hardness values higher than pearlite.

In GTAW welding changes the microstructure in the weld metal can be observed as follows.

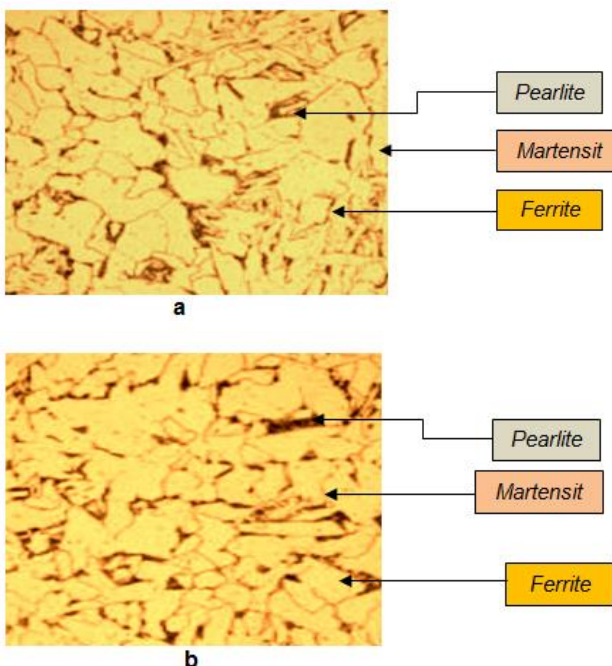


Figure 3.5 a.Composition of micro structure on GTAW welding and Non Preheat with magnification 300X, b.Composition of micro structure on GTAW welding and Preheat 125 °C with magnification 300X,

Based on the observations above photo, from specimen to specimen without preheat to preheat at 125°C temperature differences after the change. Ferrite composition of the specimen without preheat less. Compared with preheat specimens, while the composition is inversely proportional pearlite.

Changes in the microstructure because of a preheat temperature adjustment of the steel material SA 106 Gr. B to the welding temperature. At a constant temperature welding on the welding current 100 A specimen with a preheat of 125 °C will be more quickly adapted to the welding temperature. Such conditions affect the microstructure affects the mechanical properties of the steel SA 106 Gr. B

IV. CONCLUSION

From the research and analysis of testing and discussion of the data, it can be concluded preheat process influence on the mechanical properties of the material before welding. In the process SMAW and GTAW welding preheat temperature increase impact on the rising value of the tensile test at a temperature of 125°C preheat. In GTAW welding obtained $\sigma_u = 54.51 \text{ kgf/mm}^2$, whereas the SMAW welding $\sigma_u = 53.26 \text{ kgf/mm}^2$. In testing the hardness increasing effect on the preheat temperature hardness value. The maximum value of hardness in the welding area of 43.22 HBN whereas GTAW welding of 43.32 HBN.

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