Journal of Welding Technology
P-ISSN: 2716-1471 | E-ISSN: 2716-0475
http://e-jurnal.pnl.ac.id/Welding_Technology

Hardness Analysis of Weld Metal Electrode Low Hydrogen Potassium E7016 and E7018

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Abstract

Electrodes for the Manual Metal Arc (MMA) welding process or welding electrodes are classified based on the type of coating which is informed by the last digit code of the electrode. Electrodes E7016 and E7018 are basic types of electrodes with a Low Hydrogen Potassium coating type which are widely used in welding heavy construction equipment and piping. This electrode has a minimum tensile value of 70 ksi (480 MPa) with a carbon content of 0.07% for E7018 and 0.08% for E7016. The difference in carbon content in the composition of the electrode will determine the hardness value of the resulting weld. In use in the field these two electrodes are often recommended and can even be exchanged according to the assumption that the minimum tensile value is relatively the same between the two electrodes. However, due to the difference in carbon content, it will affect the hardness of the weld (weld metal) after welding. Many studies have been carried out to determine the mechanical properties of the welded joints using these electrodes, but research on the specific mechanical properties of the welds of the two electrodes is very rarely carried out. The test method is carried out by making 2 test specimens each for currents of 80A, 100A, and 120A using E7016 and E7018 electrodes with a diameter of 3.2mm. The material used is SA.36. The hardness test was carried out using the Rockwell-C (HRC) method. The test results show that the hardness value of the basic low hydrogen potassium electrode E7018 has a higher hardness value than E7016 for the same current. At currents of 80A, 100A, and 120A, there was an increase in the hardness of the E7018 weld metal against E7016 by 2.0% each; 9.8%; and 6.7%. The highest hardness value is found at 80A of 42.3HRC for the E7018 electrode, and 41.5 HRC for the E7016 electrode. In E7016 the increase in current causes a decrease in hardness level of 8.2% from 80A to 100A; 12.3% from 100A to 120A. In E7018 the increase in current causes a 1.2% decrease in hardness from 80A to 100A; 14.7% from 100A to 120A.

Keywords: weld metal, current, hardness value, electrode, low hydrogen

1. Introduction

Electrodes for Manual Metal Arc (MMA)[1] process welding or welding electrodes are classified based on the type of coating identified by the last digit code of the electrode. Electrodes E7016 and E7018 are basic type electrodes with Low Hydrogen Potassium type coating which are widely used in construction welding of heavy equipment and piping[2]. This electrode has a minimum tensile value of 70 ksi (480 MPa) with a carbon content of 0.07% for E7018 and 0.08% for E7016[3]. The difference in carbon content in the composition of the electrode will affect the hardness value of the resulting weld.

In use in the field these two electrodes are often recommended and can even replace each other according to the assumption that the minimum tensile value is relatively the same between the two electrodes. However, due to the difference in carbon content, it will affect the hardness of the weld (weld metal) after welding[4].

Previous studies related to the mechanical properties of the E7016 and E7018 electrodes were generally carried out by testing the strength of the welded joints[5][6][7]. Special research on the welds (weld metal) of the two electrodes is very rarely done. Saputro conducted a study on the effect of welding current on the tensile strength of SMAW welding with E7018 electrodes and with currents of 90A, 105A, and 130A using DCEN polarity. The results obtained for the highest tensile strength of the welded joint occurred in the 105 Ampere specimen group, which was 47.42 kgf/mm2[8]. Furthermore, W. Karmawan, conducted research on analyzing the strength of welded joints with varying currents (60A, 80A and 100A) for SMAW welding with E 7018 electrodes, ST 42 steel material for mechanical properties. The results showed that the highest tensile strength was 31.33 N/mm2 at a current of 60A and the highest impact was 0.095 N/mm^2[9]. Novendri Chairul, conducted research on the effect of variations in current strength (90A, 100A, 230A) on the tensile strength of SMAW welding results on low carbon steel with E-7018 electrodes. The results showed that the highest tensile test value was 545.58 N/mm2 at 130A[10].

The purpose of this study was to determine the weld metal hardness of the basic electrodes E7016 and E7018. The research focus is only on the welds. The

research results will be useful in considering the selection of basic low hydrogen potassium electrodes for field applications.

2. Research Methods

The material used in this research is SA 36. The welding process used is the MMA welding process with a variety of electrode types E7016 and E7018. The diameter of the electrodes used for both types of electrodes is 3.2 mm. The research method begins with the formation of welding specimens, namely the manufacture of a single V groove. The specimens were welded using both types of electrodes. The welding position is the Flat position. The type of polarity used is DCEP. At the time of welding, each electrode also varies the current, namely 80A, 100A and 120A so that there are a total of 6 specimens of the welded material. The welding process using the E7016 electrode was carried out on 3 specimens using current variations of 80A, 100A and 120A. The welding process using the E7018 electrode was also carried out on 3 specimens using current variations of 80A, 100A and 120A. After welding, a visual Non Destructive Test (NDT) inspection is carried out to see the occurrence of welding defects. If welding defects are found in the welded material, re-welding will be carried out until the specimen has no weld defects. Because welding defects can reduce the strength of the material. based on visual test results found no category of welding defects. After the welding process and visual NDT, the welded specimens were tested for hardness using the HRC method. The results of the hardness test were analyzed.

This research began with the preparation of materials and consumables for making specimens following the flow chat flow below:

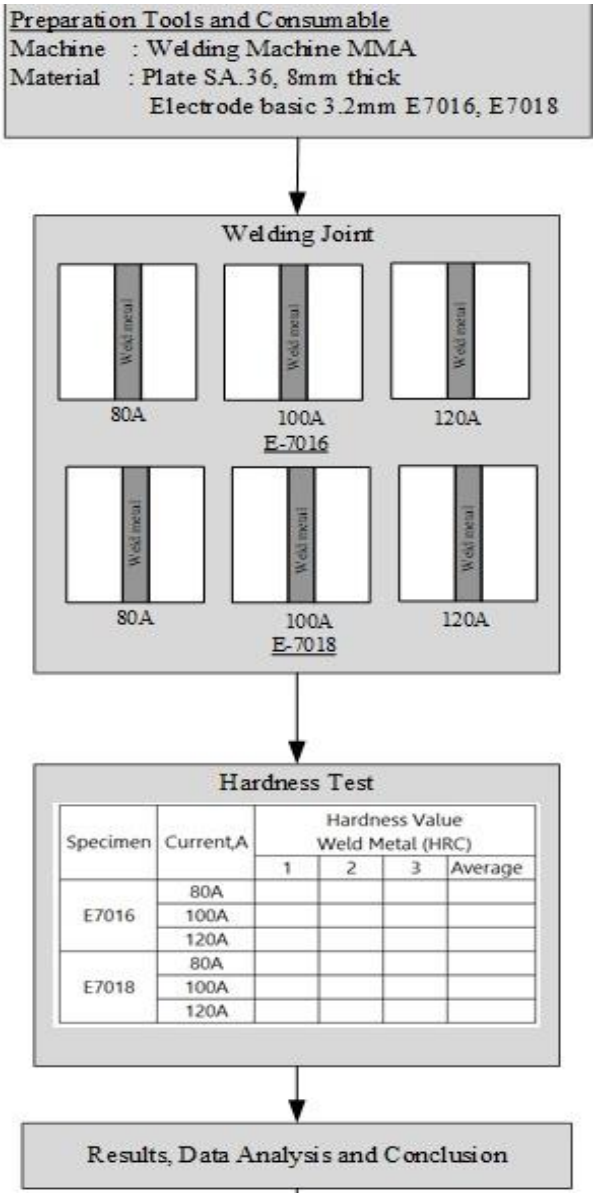

Fig. 1. Research flow chart

The weld metal resulting from the connection is shown in Figure 2 below:

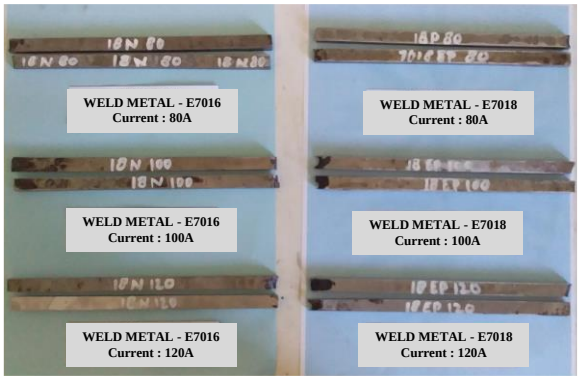

Fig. 2. Weld metal elektrode E7016 and E7018

Hardness Testing

The hardness of a material is a very important mechanical property, because it can be used to determine other mechanical properties, namely strength. Hardness test is a process that aims to determine the resistance of a material to deformation in the local area or surface of the material, especially for metal deformation which is meant by plastic deformation[11][12]. Plastic deformation itself is a state of the material in which when a force is applied, the microstructure will not return to its original shape[13][14]. There are various types of indentation hardness tests, including: Brinell, Vickers, Rockwell, Knoop hardness tests, and so on. In this study, the Rockwell-C (HRC) hardness test was used with a test load of 150 kgf[12].

3. Results and Discussion

Hardness testing was carried out on weld metal specimens with basic low hydrogen potassium electrodes E7016 and E7018 as shown in figure 3 below.

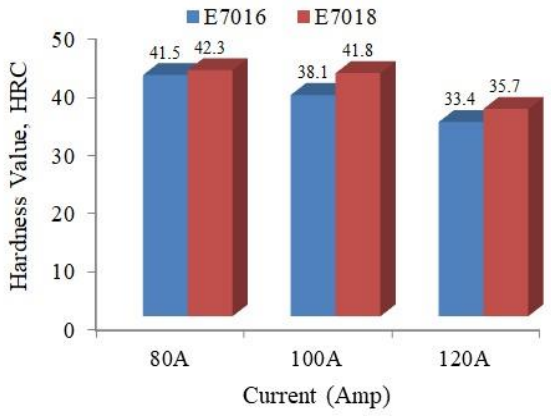

Fig. 3. E7016 and E7018 weld metal hardness values

Based on the graph above, it can be explained that the hardness value of the E7018 weld metal electrode tends to be higher than that of E7016 for each welding current, be it 80A, 100A and 120A. At currents of 80A, 100A, and 120A, there was an increase in the hardness of the E7018 weld metal against E7016 by 2.0% each; 9.8%; and 6.7%.

The highest hardness value is found at 80A of 42.3HRC for the E7018 electrode, and 41.5 HRC for the E7016 electrode. Judging from the variations in current, the increase in current can cause a significant decrease in the hardness value and can be seen in table 1 below.

Table 1. Decreasing the value of violence against increasing current (A)

Elektrode	Current	Hardness, HRC	
		Average	%
E7016	80A	41,5	0%
	100A	38,1	8,2%
	120A	33,4	12,3%
E7018	80A	42,3	0,0%
	100A	41,8	1,2%
	120A	35,7	14,7%

From the data in Table 1 it can be explained that for the basic low hydrogen potassium E7016 electrode, an increase in welding current from 80A to 100A can reduce the weld metal hardness value by 8.2% from 41.5 HRC to 38.1HRC. Furthermore, the increase in current from 100A to 120A causes the hardness value to decrease by 12.3% from 38.1HRC to 33.4HRC.

For basic low hydrogen potassium electrodes, iron powder E7018 increasing the welding current from 80A to 100A can reduce the weld metal hardness value by 1.2% from 42.3 HRC to 41.8HRC. Furthermore, the increase in current from 100A to 120A causes the hardness value to decrease by 14.7% from 41.8HRC to 35.7HRC.

4. Conclusion

Based on the results and discussion above, it can be concluded that the hardness value of the basic low hydrogen potassium electrode E7018 has a higher hardness value than E7016 for the same current. At currents of 80A, 100A, and 120A, there was an increase in the hardness of the E7018 weld metal against E7016 by 2.0% each; 9.8%; and 6.7%. The highest hardness value is found at 80A of 42.3HRC for the E7018 electrode, and 41.5 HRC for the E7016 electrode. In E7016 the increase in current causes a decrease in hardness level of 8.2% from 80A to 100A; 12.3% from 100A to 120A. In E7018 the increase in current causes a 1.2% decrease in hardness from 80A to 100A; 14.7% from 100A to 120A.

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