CORROSION STUDIES OF WELDMENT ON AA5083 IN GTAW PROCESS

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***Abstract*— Occur in spite of the fact that the proper base metal and filler metal have been selected, industry codes and standards have been followed, and welds have been deposited that possess full weld penetration and have proper shape and contour. It is not unusual to find that, although the wrought form of a metal or alloy is resistant to corrosion in a particular environment, the welded counterpart is not. Further welds can be made with the addition of filler metal or can be made autogenously (without filler metal). However, there are also many instances in which the weld exhibits corrosion resistance superior to that of the non-welded base metal. There also are times when the weld behaves in an erratic manner, displaying both resistance and susceptibility to corrosive attack. In this work we are going to identify the corrosion rate of AA5083 weldment and the base metal during Gas Tungsten Arc welding process in different currents and voltage conditions by using weight loss method. Since the AA5083 has a wide range of application in ship building prcess. And also this test on AA5083 will help to understand the variations of corrosion rate of specimens in different process parameters during welding and also it help to select the parameter which will reduce the corrosion rate of weldment**.

Keywords— Corrosion, Weight loss method, Corrosion rate, welding,AA5083

Introduction

Welding is defined by the American Welding Society (AWS) as a localized coalescence of metals or non-metals produced by either heating of the materials to a suitable temperature with or without the application of pressure, or by the application of pressure alone, with or without the use of filler metal. There are various welding processes used in industry today, the main factors for their distinctions being the Source of the energy used for welding, and the means of protection or cleaning of the welded material.

The corrosion is one of major problem in all the kinds of materials. Especially in industries they are only most suffering people. Because of corrosion the material properties and behaviours will get changed and also breakage of the material takes place.

Aluminum alloy AA5083 important lightweight structural materials that have been widely used in Aviation, aerospace, transportation and other areas for their excellent specific strength and good Weldability. In recent years, the applications of aluminum alloy sheets and their welded structures have drawn more and more attention because of their light weight and ease of processing.

In this work to analyses the corrosion behaviours of Aluminium Alloy. So we are select the base material as Aluminium Alloy 5083. By Gas Tungsten arc welding process we will make butt welding on the base material. When the welding work we going to change the process parameters like current and voltage values. So we will take few quantity of base metal with different process parameters in Gas Tungsten arc welding.

After welding process we cut done the welded portions of material. Then polishing process carried out on welded and non-welded materials. The polished work piece of microstructures will take for competition. After that the cutter portion will tested by weight loss method .now the corroded portion of microstructure will take for comparison. By this process all the corrosion rates of different process parameter welded specimens are compared.

This comparison will give the result of which kind of process parameters will give less corrosion rate in future on AA5083.

II.MATERIAL PROPERTIES

Aluminium is remarkable for its low density and ability to resist corrosion due to the phenomenon of passivation. Structural components made from aluminum and its alloys are vital to the aerospace industry and are important in other areas of transportation and structural materials. The most useful compounds of aluminium, at least on a weight basis, are the oxides and sulphates. Aluminium 5083 is a high strength non-heat treatable alloy in commercial use. The major additive in the alloy is Magnesium. It has good formability and weldability and retains excellent tensile strength in the weld zone. It has excellent resistance to corrosion and high strength-to-weight ratio. The experimental material is selected as 5083 Al alloy sheets of 10 mm thickness, which is welded by GTA Welding.

Table 1: Properties of AA5083

S.No	Parameters	Symbol	Values	Units
1	Young's Modulus	E	72	GPa
2	Poisson's Ratio	υ	0.33	-
3	Density	P	2650	Kg/m^3
4	Tensile Strength	σ_t	260	MPa
5	Specific Thermal Capacity	C	900	J/kg K
6	Thermal Conductivity	K	121	W/Mk
7	Thermal Expansion	A	$25X10^{-6}$	/K
8	Melting Point	-	570	^0C
9	Latent Heat		$0.80x10^{-9}$	J/m^3
10	Liquids Temperature	-	638	^0C
11	Solids Temperature	-	591	^0C

III.CORROSION IN WELDMENTS

Corrosion failures of welds occur in spite of the fact that the proper base metal and filler metal have been selected, industry codes and standards have been followed, and welds have been deposited that possess full weld penetration and have proper shape and contour. It is not unusual to find that, although the wrought form of a metal or alloy is resistant to corrosion in a particular environment, the welded counterpart is not. Further welds can be made with the addition of filler metal or can be made autogenously (without filler metal). However, there are also many instances in which the weld exhibits corrosion resistance superior to that of the unwedded base metal. There also are times when the weld behaves in an erratic manner, displaying both resistance and susceptibility to corrosive attack. It is sometimes difficult to determine why welds corrode; however, one or more of the following factors often are implicated:

- Weldment design
- Fabrication technique
- Welding sequence
- Moisture contamination
- Oxide film and scale
- Weld slag and spatter

3.1 CORROSION TESTING AND MONITORING TECHNIQUES

1. Weight loss coupon
2. Oxalic test
3. Ferritic test
4. Electrical resistance (ER)
5. Electrochemical impedance spectroscopy (EIS)
6. Potentiodynamic anodic polarisation
7. Electrochemical noise
8. Hydrogen monitoring

3.1.1 WEIGHT LOSS ANALYSIS

The simplest, and longest-established, method of estimating corrosion losses in plant and equipment is weight loss analysis. A weighed sample (coupon) of the metal or alloy under consideration is introduced into the process, and later removed after a reasonable time interval.

- Simple - No sophisticated instrumentation is required to obtain a result.
- Direct - A direct measurement is obtained, with no theoretical assumptions or approximations.

Weight Loss and Corrosion Rate Determination

In the laboratory, outer soil debris on the coupons was carefully removed. They were then cleaned with inhibited acid (15% HCl) to remove corrosion products on the surface of the coupons according to ASTM G1 (Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens). The coupons were then rinsed under running water. Next, the coupons were placed in an oven at 70°C for 15 minutes to dry them. After drying, they were placed in a desiccator to cool after which they were weighed to a constant weight using a Mettle Toledo weighing balance (New Classic ML 204, Switzerland). The weight of the retrieved coupons before cleaning was compared to the initial weight, the difference indicating the metal loss during the exposure period. The corresponding average percentage weight loss (APWL) and corrosion rate (CR) were calculated. Corrosion rate was calculated assuming uniform corrosion over the entire surface of the coupons. The corrosion rate in mils per year (mpy) was calculated from the weight loss using the formula: The weight loss is converted to a corrosion rate (CR) or metal loss (ML), as follows:

$$\text{Corrosion Rate (CR)} = \frac{\text{Weight loss (g)} * K}{\text{Alloy Density (g/cm}^3) * \text{Exposed Area (A)} * \text{Exposure Time (hr)}}$$

The coupons were weighed after cleaning to determine the general corrosion rates in each solution. In all cases where the coupons were immersed in solutions that contained 3 M nitric acid, the general corrosion was so severe that the stamped identification marks were no longer visible. In these cases, the total weight and total surface area of the 2 coupons were added together to obtain an average corrosion rate for the material in a given solution.

The corrosion rates for each test are shown in Table. The corrosion rates appear to be reproducible as coupons from the same solution had similar corrosion rates. The corrosion rates for both types of steel were also similar for the same test solution.

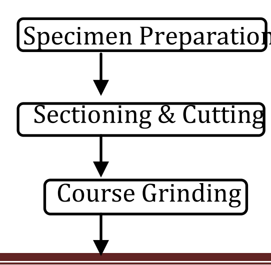
3.1.2 OXALIC ACID CORROSION TEST

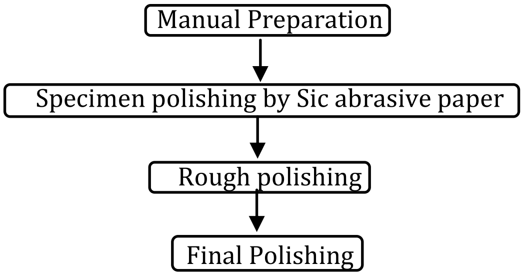
The oxalic acid etch test is a rapid method of screening specimens of certain stainless steel grades which are essentially free of susceptibility to intergranular attack associated with chromium carbide participates. The test is used for acceptance, but not rejection, of material.

This test may be used in conjunction with other tests to provide a quick method for identifying specimens that are certain to be free of susceptibility to rapid intergranular attack. These specimens are identified by means of their etch structures.

IV. EXPERIMENTAL WORK

Specimen Preparation





Testing procedure

- Polish the AA5083 material test samples by using silicon carbide sheet
- By polishing machine polish the test samples with abrasive mixture. Here abrasive mixture is prepared by Al_2O_3 (aluminum oxide) mixed with distilled water.

Fig 1 . Specimen 1: before corrosion test

Fig .2. Specimen 2: before corrosion test

- Prepare the 3 normality HCL solution with distilled water. For 100ml of solution add 27ml of HCL with 73ml of distilled water in 5 different beakers for 5 sample specimens.
- Take weight (W1) of all the 5 samples by weighing machine in grams before corrosion test.
- Take the dimensions of all the AA5083 samples before corrosion test piece.
- Dip the samples in different beakers up to 48 hours.

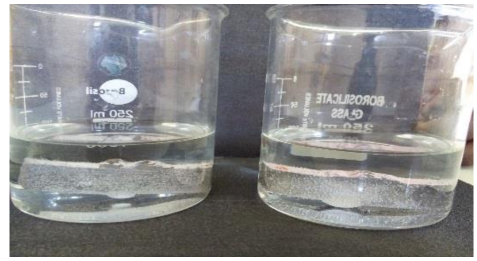


Fig 3. Corrosion test samples in solution

- Take the test samples from the solution after 3 hours.

Fig 4. Specimen 1: After corrosion

Fig 5. Specimen 2: After corrosion

- Measure the weight (W2) of all the 5 tested samples by weighing machine after corrosion test.
- Find the corrosion rate by using following formula.

$$R_{corr} = 10^4 \times \frac{W}{\rho \times A \times t}$$

V. RESULT AND DISCUSSION

Weight loss method Calculations:

1 Normality of HCL solution = 9 ml.

In 100 ml of solution with 1 normality requires 81ml of distilled water and 9ml of concentrated HCL acid.

For 3 normality HCL solution,

Distilled water = 73 ml

Concentrated HCL = 27 ml

Sample 1:

Density of the material (ρ) = 7.8 grams/cm^3.

Time (t) = 48 hours.

Dimensions of the material:

Dimensions 1 :(for two sides)

Length =5cm

Breath =1.3cm

Dimensions 2 :(for two sides)

Length =5cm

Breath =1cm

Dimensions 3 :(for two sides)

Length =1.3cm

Breath =1cm

Area calculation:

Area 1 = length x breath x 2 (for two sides)

=5 x 1.3 x 2

Area 1 =13cm^2.

Area 2 = length x breath x 2 (for two sides)

=5 x 1 x 2

Area2 =10cm^2.

Area 3 = length x breath x 2 (for two sides)

=1.3 x 1 x 2

Area 3 =2.6cm^2.

Total Area =Area1+Area2+Area3

=13+10+2.6

Total Area =25.6cm^2

Weight loss calculation

Weight of the material before corrosion (w1)

= 15.9 grams.

Weight of the material after corrosion (w2)

= 10 grams

Weight loss (W) = W1-W2

= 15.9-10

W = 5.9 grams.

Corrosion rate formula:

$$R_{corr} = 10^4 \times \frac{W}{\rho \times A \times t}$$

$$R_{corr} = 10^4 \times \frac{0.0059}{2650 \times 25.6 \times 0.005479452}$$

=158.7x10^3 µm/year.

R_{corr} =0.1587 meter/year.

Table 2: Corrosion rates with process parameters

Sample No.	Current I (amps)	Voltage V (volts)	Weight before corrosion W1 (grams)	Weight after corrosion W2 (grams)	Total weight loss W (W1-W2) (grams)	Corrosion Rate Rcorr (1x10^{3}µm/year)
1	200	23	11	9	2	53.8
2	210	23	12.2	9.2	3	80.7
3	220	22	13.6	9.6	4	107.6
4	240	24	14.7	10	4.7	126.4
5	265	24	15.9	10	5.9	158.7

VI. CONCLUSION

By this project we analyzed the corrosion behaviors of Gas tungsten arc welded AA5083. We were took 5 different specimens, all are differ by process parameters like current and voltage when Gas tungsten arc welding process.

Through this results by the comparison of all different specimens we suggest that we can maintain process parameters as follows means we can reduce the corrosion rate of weldment in AA5083 with Gas tungsten arc welding process.

Current =200 amps

Voltage =23 volts

By this parameters we can achieve the less quantity of corrosion rate. As

Corrosion rate =53.8 x 10^3 µm/year

Through our project we identified that when the current value of welding process increase the corrosion rate of the weldment will be decreased.

Our future work will be how to prevent the corrosion in weldment of AA5083 .so we will going to give the coatings by different Nano particles.

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