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OAK RIDGE Y-12 PLANT

MARTIN MARIETTA

CLEANING OF ALUMINUM ALLOY 5083

Compiled by
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MASTER

CLEANING OF ALUMINUM ALLOY 5083

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SUMMARY

The purpose of this investigation was to evaluate several different cleaning procedures on welds with very low heat inputs. The study evaluated the Oak Ridge Y-12 Plant's chemical cleaning, another type of chemical cleaning, ion cleaning, and diamond-machined cleaning. The results showed that the diamond-machining process provides better weld joint surfaces and sound welds with minimum oxide inclusion and porosity.

INTRODUCTION

This investigation evaluated pulsed, gas-tungsten arc welding as a potential method for welding aluminum alloy 5083 with full penetration and no or minimal porosity.

PRESENTATION OF EXPERIMENTAL WORK

Examination of weld failures in aluminum alloy 5083 found oxide stringers through the majority of the material thicknesses to be the initial cause of failure. One solution of the problem was to provide better cleaning of the joint.

A previous cleaning study had been done using a high-heat-input weld. The new cleaning study used low heat input and compared (1) the Oak Ridge Y-12 Plant's standard chemical cleaning, (2) a modified chemical cleaning, (3) ion cleaning, and (4) diamond machining.

Both chemical cleaning procedures are presented in Table 1. The study used Y-12 Plant chemically cleaned rings as standards. Another modified chemical cleaning was performed at the Y-12 Plant under the same conditions as those of Y-12's chemical cleaning. The diamond-machined rings were machined at the Y-12 Plant. All of the cleaned surfaces were analyzed for surface topography, oxide thickness, and residue on the cleaned surface. Analysis indicated that the Y-12, the other chemically cleaned surfaces, and the diamond-machined surface had approximately the same oxide thickness (10 Å). The two major differences were the residue on the surface of the part and the topography of the surfaces. The chemically cleaned samples contained most of the chemicals present in the chemical bath. The diamond-machined part is very flat, and the lighter areas are the magnesium in the aluminum alloy 5083. The other chemically cleaned surface shows a pitted surface; the Y-12 Plant chemically cleaned surface is very rough and has a fragmented appearance. Magnesium and aluminum hydroxides are much more prevalent on both chemically clean surfaces because of the contact with chemical and rinsing solutions. Rings cleaned by each process were welded at a very low heat input. Diamond-machined cleaning provided better penetration and less porosity by both visual and radiographic examination.

Table 1. Alternate chemical cleaning procedure^a

Step	Type	Temperature (°C)	Time (s)
Vapor degrease in hexane	Immerse	58	60-70
Acid etch in chromic sulfuric acid ^b	Immerse and agitate	65.5	30
Rinse in demineralized water	Immerse and agitate	-27	15-20
Acid etch in phosphoric-nitric acid ^c	Immerse and agitate	95	30
Rinse in hot demineralized water	Immerse and agitate	50	15-20
Rinse in demineralized water	Immerse and agitate	-27	15-20
Rinse in demineralized water	Immerse and agitate	-27	15-20
Dry with hot forced air	-	-	3.5

^aOak Ridge Y-12 Plant's chemical cleaning procedure is the same except steps 2, 3, and 5 are excluded and the temperature of step 4 = 33°C.

^bUse chromic trioxide (19 g), water (200 mL), and sulfuric acid (55 mL); dilute to 500-mL solution.

^cUse phosphoric acid (405 mL), nitric acid (15 mL), and water (80 mL).

Two parts were welded by using the diamond-machined surface. Neither showed evidence of porosity when examined by ultrasonic testing. One part was cut and sampled every 12.2 mm, and the largest porosity found was 0.102 mm in diameter. No oxide stringers were found in the samples examined. Both parts were welded at the same heat input (72 average A), as was the group of 11 units that contained defects due to oxide stringers. Therefore, results indicate that diamond machining enables welding at a lower heat input and provides a weld free from oxide inclusions.

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