



Technical Service Report

Customer	Ensitech Pty Ltd
Contact	Clive White
Reported by	Simon Lewer
Control number	GIE-E-016
Date	15 th February 2012
Work Requested	<p>Gauge Industrial and Environmental Pty Ltd was commissioned by Ensitech Pty Ltd. to conduct a study into the passivation of stainless steel after the use of Ensitech's TIG Brush™ employing the weld cleaning fluid TB-31ND Neutral Weld Cleaning Fluid for Stainless Steel (TB-31ND).</p> <p>ASTM A967-05 "Chemical Passivation Treatments for Stainless Steel Parts" Practice 14, 17 and 18 were used in this study as the most appropriate guide for determining the performance of the TIG Brush™ with TB-31ND to passivate 316 and 445 stainless steel successfully.</p> <p>The ASTM B912-02 "Passivation of Stainless Steels using Electropolishing" Section 6 test procedures calls for the same tests as ASTM A967-05, therefore compliance with the B912-02 standard was also required.</p>

Specifically, the request for work was:

1. Clean 316 stainless steel samples with the Ensitech TIG Brush™ using Ensitech's TB-31ND.
2. Clean 445 stainless steel samples with the Ensitech TIG Brush™ using Ensitech's TB-31ND.
3. Conduct three passivation studies as per ASTM A967-05 "Chemical Passivation Treatments for Stainless Steel Parts".
4. Report on the success or otherwise of the TIG Brush™ using TB-31ND to passivate 316 and 445 stainless steel.

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Method

1. A TIG Brush™ was used throughout this study as per manufacturer's instruction providing 13 volts alternating current*.
2. The method of cleaning was as per Ensitech's instruction which included saturating the tip with the TB-31ND and contacting the tip of the brush on the area to be cleaned.
3. TB-25 Weld Cleaning Fluid for Stainless Steel (TB-25) was used as a positive control in this study based on its passivation performance in the GIE-E-012 passivation study. TB-25 was used in the same way as TB-31ND in cleaning the sample. A new brush was used for the TB-25 cleaning.
4. To eliminate contamination, the brush for each chemical was triple rinsed in deionised water between each sample.
4. The batches of TB-31ND and TB-25 fluids were both manufactured in February 2012. The chemicals were samples of production batches.
5. Samples of 316 and 445 stainless steel were supplied by Ensitech. The welded samples were TIG welded.
6. Both welded and unwelded samples were treated and subsequently tested.
7. All treatments were performed in triplicate.
8. Both 316 and 445 stainless steel were tested for passivation as per ASTM A967-05 Practice A – Water Immersion Test.
9. 316 samples were tested for passivation as per ASTM A967-05 Practice E- Potassium ferricyanide-nitric acid test. The method was followed including the making of the Potassium ferricyanide-nitric acid solution on the day of testing. A ferrous sulphate spike was added to a blank piece of 316 stainless steel acting as a positive control.
10. 445 samples were tested for passivation as per ASTM A967-05 Practice D- Copper Sulphate Test.

* The electrical offer can be achieved using any of the following TIG Brush™ models and settings:

TB-250 setting "3B"

TBX-150 / TBE-150 setting "Clean" output

TBX-300 / TBE-250 setting "High Power / Clean Mode"

TBE-700 setting "Low Power / Clean Mode"

Material	Type	Treatment	Test	
			Water Immersion	Potassium ferricyanide-nitric acid
316	Unwelded	None	3	3
		TB-31ND	3	3
		TB-25	3	3
	Welded	None	3	3
		TB-31ND	3	3
		TB-25	3	3
		Total	18	18
			Water Immersion	Copper Sulphate
445	Unwelded	None	3	3
		TB-31ND	3	3
		TB-25	3	3
	Welded	None	3	3
		TB-31ND	3	3
		TB-25	3	3
		Total	18	18

Table 1: Sample Type and Numbers of Samples

Results

Material	Type	Treatment	Test	
			Water Immersion	Potassium ferricyanide-nitric acid
316	Unwelded	None	-,-,-	-,-,-
		TB-31ND	-,-,-	-,-,-
		TB-25	-,-,-	-,-,-
	Welded	None	++,+++,++	++,+++,++
		TB-31ND	-,-,-	-,-,-
		TB-25	-,-,-	-,-,-
			Water Immersion	Copper sulphate
445	Unwelded	None	-,-,-	-,-,-
		TB-31ND	-,-,-	-,-,-
		TB-25	-,-,-	-,-,-
	Welded	None	+,+,+	+,+,+
		TB-31ND	-,-,-	-,-,-
		TB-25	-,-,-	-,-,-

Table 2: Results of Passivation Testing (triplicates)

Key: - = no reaction/no sign of corrosion or staining
 + = a reaction /positive observation of corrosion or staining
 Number of + indicates degree of corrosion or staining (where +++ is high and + is low)

Note: The ferrous sulphate spike on 316 tested positive in potassium ferricyanide-nitric acid test indicating efficacy of the test solution.

Test Sample Images



Figure 1: 316 samples: Potassium Ferricyanide – Nitric Acid Test

Note the blue staining in the centre image of an uncleaned sample indicating free iron. Note no blue staining in the right image of a sample cleaned using the TIG Brush™ with TB-31ND.



Figure 2: 445 samples: Copper Sulphate test.

Note the copper colouration arrowed on the uncleaned weld sample compared to no copper colouration on the sample cleaned with the TIG Brush™ using TB-31ND.

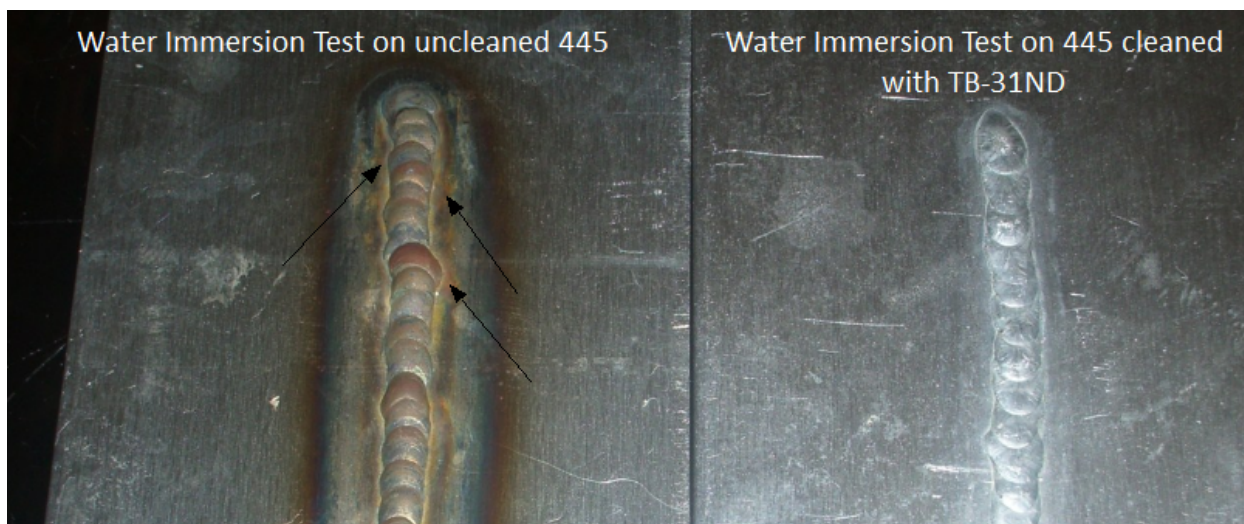


Figure 3: 445 samples: Water Immersion Test

Note the rust colouration arrowed on the uncleaned weld sample compared to no rust coloration on the sample cleaned with the TIG Brush™ using TB-31ND.

Description of Results

- All unwelded samples showed NO evidence of corrosion or staining in any test. This was true for unwelded samples uncleaned or cleaned with the TIG Brush™. This was an expected result since the passive chromium oxide layer had not been disrupted by welding.
- Welding of the 316 samples compromised their ability to resist corrosion. This was shown by signs of corrosion in the water immersion test and also strong positives for free iron in the Potassium ferricyanide-nitric acid test.
- Welding of the 445 samples compromised their ability to resist corrosion. This was shown by signs of corrosion in the water immersion test and also strong positives for free iron in the Copper Sulphate test.
- All welded 316 samples cleaned with the TIG Brush™ using TB-31ND showed no signs of corrosion in the water immersion test and negative results for free iron in the Potassium ferricyanide-nitric acid test.
- All welded 445 samples cleaned with the TIG Brush™ using TB-31ND showed no signs of corrosion in the water immersion test and negative results for free iron in the Copper sulphate test.
- All welded samples cleaned with TB-25 showed negative results in Water Immersion, Potassium ferricyanide – nitric acid and Copper sulphate tests indicating passivation compliant with ASTM A967-05 and consistent with results found in the 2010 GIE-E-012 passivation study.

Interpretation and Conclusions

Welding of stainless steel is an operation that reduces the material's ability to resist corrosion. This is due to the disruption of the passivating dense chromium oxide layer and creation of a surface oxide layer which contains iron and is not resistant to oxygen penetration which allows the continuing corrosion of the weld. The removal of iron in the surface layer allows the dense chromium layer to re-establish which passivates the weld and returns the material to an equivalent corrosion resistance to that of unwelded stainless steel.

This study determined that the use of the TIG Brush™ as per Ensitech's use recommendations with TB-31ND fluid provides effective passivation of both 316 and 445 stainless steels compliant via three standard methods of ASTM A967-05 "Chemical Passivation Treatments for Stainless Steel Parts, as well as complying with ASTM B912-02 "Passivation of Stainless Steels using Electropolishing" Section 6.

References:

ASTM A967-05 "Chemical Passivation Treatments for Stainless Steel Parts; ASTM International

ASTM B912-02 "Passivation of Stainless Steels using Electropolishing"; ASTM International

Technical Guidelines on TIG Brush™ use for cleaning stainless steel. Ensitech Pty Ltd.

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