CLEANING LABORATORY EVALUATION SUMMARY

SCL #:	2005
DateRun:	06/19/2005
Experimenters:	Jason Marshall
ClientType:	Chemical Company
ProjectNumber:	Project #1
Substrates:	Aluminum
PartType:	Coupon
Contaminants:	
Cleaning Methods:	Immersion/Soak
Analytical Methods:	Gravimetric
Purpose:	To conduct corrosion test on two solutions using aluminum coupons.
Experimental Procedure:	Testing was conducted following ASTM G21-72 (2004) Standard Practice for Laboratory Immersion Corrosion Testing of Metals. This practice, rather than a standardized procedure is presented as a guide so that some of the pitfalls of such testing may be avoided. Coupon corrosion testing is predominantly designed to investigate general corrosion. Coupons with a large surface-to-mass ratio and a small ratio of edge area to total area were used. Two inch square coupons were used that had a thickness of 0.034" thick. The temperature was held at 71 F +/- 2 F. The volume of the test solution should be large enough to avoid any appreciable change in its corrosivity during the test, either through exhaustion of corrosive constituents or by accumulating of corrosion products that might affect further corrosion. The lab filled 600 ml Pyrex beakers with 500 mls of each solution. Solutions used were Union 1760 AU-1 (stock), Union 1760 Residue Remover, DI water, Union 1760 AU-1 (stock) with 0.25g boric acid, Union 1760 Residue Remover with 0.125g boric acid and DI water with 0.25g boric acid. Eighteen aluminum coupons (AL-1100) were precleaned for five minutes in a 5% solution of Armakleen M Aero in an ultrasonic tank. Cleaned coupons were rinsed in tap water at 120 F for 15 seconds and dried using compressed air for 30 seconds. The coupons were then weighed to establish baseline weights. Three coupons were immersed into each solution, suspended by stainless steel hooks. Beakers were then covered with parafilm to reduce evaporation or contamination of the solutions. The soak time was set at 24 hours (1440 minutes). At the end of the soak time, coupons were removed from the beakers and observations were made prior to cleaning. Coupons were cleaned for 15 seconds in M Aero 5% solution using immersion soaking. Coupons were not rinsed but were dried using compressed air for 15 seconds. Dry coupons were then weighed to determine the amount of weight loss if any. After reweighing, coupons were examined for the presence of pits. Interpretation of Results The mass loss during the test period can be used as the principal measure of corrosion. Average corrosion rate can be calculated from the following equation: Corrosion Rate = (K*W)/(A*T*D) K = a constant T = time of exposure in hours to the nearest 0.01 h A = area in cm2 to the nearest 0.01 cm2 W = mass loss in g, to the nearest 1 mg (corrected for any loss during cleaning) D = density in g/cm3 Corrosion Rate Units Desired Constant (K) in Corrosion Rate Equation mils per year (mpy) 3.45 x 10^6 inches per year (ipy) 3.45 x 10^3 inches per month (ipm) 2.87 x 10^2 millimeters per year (mm/y) 8.76 x 10^4 micrometers per year (um/y) 8.76 x 10^7 picometers per second (pm/s) 2.78 x 10^6 g per sq. meter per hour (g/m2-h) 1.00 x 10^4 x D (Using g per sq. meter per hour will eliminate the need to use density in the calculations as the density is cancelled out.)
Results:	The stock solution with and without boric acid, acted similarly on the aluminum coupons. Each set of coupons lost over 0.5 grams in mass after soaking for 24 hours at 71 F. The two Residue Remover solutions also behaved similarly, losing just over 0.05 grams. The coupons soaked in water had no appreciable loss (or gain) in mass after soaking.

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Solution	Coupon	Initial Wt	24 Soak Wt	Wt Loss	Ave Wt Change	Coupon Obs.	Overall Observations
Stock	1	10.7618	10.2856	0.4762	0.5216	some pitting	Top of support holes were etched away.
	2	10.7698	10.4660	0.3038		little pitting	
	3	10.7687	9.9839	0.7848		some pitting	
Residue	4	10.7923	10.7325	0.0598	0.0547	no visible change	Some residue build up on coupons. Rinsed/ wiped off.
	5	10.7838	10.6950	0.0888		no visible change	
	6	10.7579	10.7425	0.0154		no visible change	
Water	8	10.7692	10.7676	0.0016	0.0002	no visible change	No change in coupons.
	9	10.7802	10.7807	-0.0005		no visible change	
	10	10.8151	10.8155	-0.0004		no visible change	
Stock w/boric Acid	11	10.7534	10.5595	0.1939	0.5397	pitting along edge	Less visible damage to coupons than without boric acid. Only one coupon support hole etched away.
	12	10.5097	9.9075	0.6022		severe pitting	
	13	10.5168	9.6939	0.8229		severe pitting	
Residue w/boric acid	14	10.6366	10.5840	0.0526	0.0617	no visible change	Little to no change in appearance.
	15	10.6195	10.5469	0.0726		loss of coupon luster	
	16	10.6344	10.5744	0.0600		no visible change	
Water w/boric Acid	17	10.6268	10.6275	-0.0007	-0.0004	no visible change	No change in coupons.
	18	10.6781	10.6775	0.0006		no visible change	
	19	10.7825	10.7836	-0.0011		no visible change	

Summary

Product	Corrosion Rate (g/m2-h)
Stock	0.00842
Residue	0.00088
Water	0.00000
Stock w/ boric Acid	0.00872
Residue w/boric acid	0.00100
Water w/ boric Acid	-0.00001

Summary:

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Conclusion:	Both boric acid mixes lost more weight than the boric acid free solutions. The stock solution resulted in the most damage to the aluminum coupons.