TECHNOTES
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Corrosion of Metals in Chlorine-Containing Disinfectant Solutions:

TexTab™ TX6460 versus Sodium Hypochlorite

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Introduction

The corrosiveness of solutions of TexTab TX6460 and sodium hypochlorite were tested in accordance with the Standard Guide for Laboratory Immersion Corrosion Testing of Metals (NACE TM0169/G31-12a). The stainless steels 304, 316, and aluminum metal samples tested were 25 mm (1") in diameter with a drilled hole.

Procedure

The metal samples were cleaned using a scouring pad and methanol. The samples were dried carefully ensuring no dust or residue was left on the surface. Test solutions of 1,000 ppm, 2,000 ppm and 5,000 ppm chlorine were prepared in by dissolving TexTab TX6460 tablets in deionized water. Sodium hypochlorite solutions of 1,000 ppm, 2,000 ppm and 5,000 ppm chlorine were prepared by dilution with deionized water.

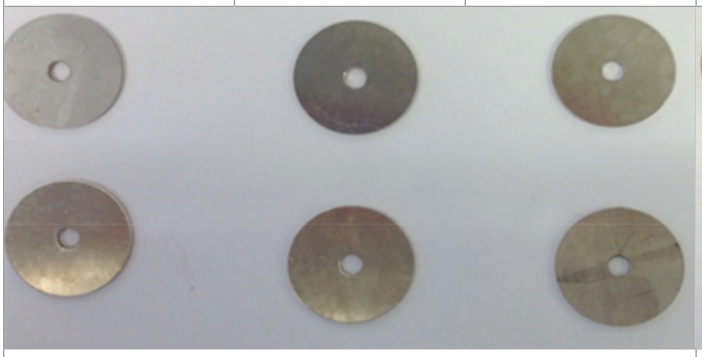
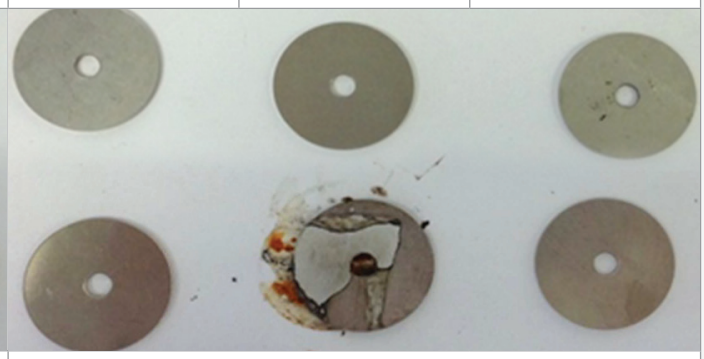
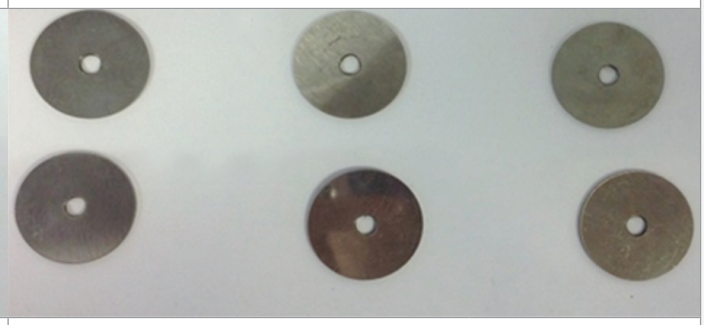
The chlorine concentration and pH of the solutions were measured at the beginning of the test. Test solutions (200 - 230 ml) were put in sealable test vessels to a depth sufficient to cover the sample. The sample weight was recorded and the sample was photographed. One sample was suspended in each test vessel with fishing line looped through the center hole. The samples were submerged in the test solution for 30 days at room temperature.

After 30 days the samples were visually inspected and photographed for corrosion. The samples were dried and any corrosion was removed using a lightly abrasive bristle brush before weighing. Each test solution was reanalyzed for chlorine and pH.

Results

Most stainless steel samples retained a lustrous appearance after 30 days in both TexTab and hypochlorite solutions. One 304 sample was corroded in 2,000 ppm hypochlorite but this may have been the result of a defect in the machining of the sample. Aluminum samples were more corroded in hypochlorite solutions losing their luster. There was slight salt deposition of samples in TexTab. However, rubbing with a bristle brush restored the appearance of the samples.

Table 1. *Visual inspection of metals after 30 days in solution*

TexTab			Sodium Hypochlorite		
1,000 ppm	2,000 ppm	5,000 ppm	1,000 ppm	2,000 ppm	5,000 ppm
					
Stainless steel 304. No corrosion.			Some corrosion on one sample at 2,000 ppm.		
					
Stainless steel 304. No corrosion.			No corrosion.		
					
Aluminum. At 1,000 ppm Cl, salt deposits on the surface. At 2,000 ppm and 5,000 ppm – slight corrosion of the samples but the metal was still lustrous. Deposits on the sample, possibly chloride salt.			All samples highly tarnished and had lost their metallic lustrous surface. High level of chloride salt deposits on the surface.		

The pH of solutions varied little over the 30 day trial. pH of TexTabs solutions were ~6. pH of hypochlorite was 11-12. This higher pH causes corrosion of aluminum (Tables 2-3). The sample weights were unchanged over 30 days for TexTabs with only a very slight increase (0.40%) of one of the samples in 5,000 ppm (Tables 4-6). The weight change was much greater for aluminum in hypochlorite with weight gains in excess of 3% seen for some samples (Tables 7-9).

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Table 2. *Initial and final pH of TexTab solutions.*

pH	1,000 ppm	2,000 ppm	5,000 ppm
Initial pH	**5.98**	**5.77**	**5.86**
Stainless Steel 304	6.07	6.02	5.97
Stainless Steel 304	6.04	5.97	5.93
Stainless Steel 316	6.33	5.96	5.87
Stainless Steel 316	6.17	6.06	5.82
Aluminum	5.95	6.04	5.91
Aluminum	6.04	6.03	5.88

Table 3. *Initial and final pH of various hypochlorite solutions.*

pH	1,000 ppm	2,000 ppm	5,000 ppm
Initial pH	**11.33**	**11.71**	**12.23**
Stainless Steel 304	11.3	11.75	12.17
Stainless Steel 304	11.3	11.74	12.23
Stainless Steel 316	11.63	11.8	12.13
Stainless Steel 316	11.52	11.49	12.21
Aluminum	10.81	11.39	11.69
Aluminum	10.79	11.55	11.78

Table 4. *1,000 ppm TexTab samples.*

Metal	Initial Weight (g)	Final Weight (g)	Comment	% Change
Stainless Steel 304	7.55	7.55	No change	0.00
Stainless Steel 304	7.57	7.57	No change	0.00
Stainless Steel 316	7.65	7.65	No change	0.00
Stainless Steel 316	7.67	7.67	No change	0.00
Aluminum	2.52	2.52	No change	0.00
Aluminum	2.52	2.52	No change	0.00

Table 5. *2,000 ppm TexTab samples.*

Metal	Initial Weight (g)	Final Weight (g)	Comment	% Change
Stainless Steel 304	7.56	7.56	No change	0.00
Stainless Steel 304	7.55	7.55	No change	0.00
Stainless Steel 316	7.57	7.57	No change	0.00
Stainless Steel 316	7.59	7.59	No change	0.00
Aluminum	2.51	2.51	No change	0.00
Aluminum	2.50	2.50	No change	0.00

Table 6. *5,000 ppm TexTab samples.*

Metal	Initial Weight (g)	Final Weight (g)	Comment	% Change
Stainless Steel 304	7.13	7.13	No change	0.00
Stainless Steel 304	7.57	7.57	No change	0.00
Stainless Steel 316	7.65	7.65	No change	0.00
Stainless Steel 316	7.55	7.55	No change	0.00
Aluminum	2.51	2.51	No change	0.00
Aluminum	2.50	2.51	Weight increase	0.40

Table 7. *1,000 ppm Hypochlorite samples.*

Metal	Initial Weight (g)	Final Weight (g)	Comment	% Change
Stainless Steel 304	7.57	7.57	No change	0.00
Stainless Steel 304	7.56	7.56	No change	0.00
Stainless Steel 316	7.65	7.65	No change	0.00
Stainless Steel 316	7.67	7.67	No change	0.00
Aluminum	2.51	2.52	Weight increase	0.40
Aluminum	2.51	2.52	Weight increase	0.40

Table 8. *2,000 ppm Hypochlorite samples.*

Metal	Initial Weight (g)	Final Weight (g)	Comment	% Change
Stainless Steel 304	7.55	7.55	No change	0.00
Stainless Steel 304	7.6	7.9	Weight increase	3.95
Stainless Steel 316	7.57	7.57	No change	0.00
Stainless Steel 316	7.59	7.59	No change	0.00
Aluminum	2.57	2.59	Weight increase	3.19
Aluminum	2.51	2.58	Weight increase	2.79

Table 9. *5,000 ppm Hypochlorite samples.*

Metal	Initial Weight (g)	Final Weight (g)	Comment	% Change
Stainless Steel 304	7.54	7.54	No change	0.00
Stainless Steel 304	7.54	7.54	No change	0.00
Stainless Steel 316	7.65	7.65	No change	0.00
Stainless Steel 316	7.55	7.55	No change	0.00
Aluminum	2.51	2.54	Weight increase	1.20
Aluminum	2.52	2.61	Weight increase	3.57

The TexTab solutions were much more stable over the 30 day trial period. Activity was generally in excess of 70% of initial assay for 1,000, 2000 and 5,000 ppm solutions with all 3 metals (Table 10). Hypochlorite solutions were less stable over 30 days with <50% activity remaining in all samples. In samples with aluminum activity declined to 30%.

Table 10. *Initial and 30 day Cl_2 Concentration of TexTab solutions*

pH	1,000 ppm	%	2,000 ppm	%	5,000 ppm	%
Initial concentration	1092		2128		5135	
Stainless Steel 304	794	79	1518	76	3589	72
Stainless Steel 304	780	78	1504	75	3603	72
Stainless Steel 316	780	78	1518	76	3589	72
Stainless Steel 316	780	78	1504	75	3560	71
Aluminum	752	75	1504	75	3433	69
Aluminum	752	75	1518	76	3489	70

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Table 11. *Initial and 30 day Cl_2 Concentration of Hypochlorite solutions*

pH	1,000 ppm	%	2,000 ppm	%	5,000 ppm	%
Initial concentration	1052		2098		5101	
Stainless Steel 304	468	47	879	44	2199	44
Stainless Steel 304	468	47	142	7	2199	44
Stainless Steel 316	468	47	879	44	2199	44
Stainless Steel 316	468	47	879	44	2213	44
Aluminum	298	30	567	28	1617	32
Aluminum	298	30	539	27	1206	24

Discussion

In general no corrosion was present on stainless steel samples. One of the stainless steel 304 samples that was submerged in a 2,000 ppm chlorine solution prepared with sodium hypochlorite had a small area of corrosion which seemed to have begun at the center of the coin where the hole had been drilled. No corrosion was seen on the samples submerged in 5,000 ppm Cl solutions.

For the aluminum samples tested small areas of approximately 5 mm^2 were slightly tarnished and had salt deposits on them when submerged in 1,000 ppm TexTab. The extent of this corrosion gradually increased as the ppm of chlorine increased. At 5,000 ppm the TexTab samples had some areas of 1cm^2 corroded. All aluminum samples submerged in TexTab solutions were still lustrous after 30 days and it was possible to remove the corrosion with a bristle brush. All of the aluminum samples submerged in sodium hypochlorite solutions were highly tarnished and were no longer metallic or lustrous. The corrosion on these samples was very difficult to remove and even when some corrosion was removed the coins were no longer lustrous.

It was also noted that the hypochlorite solutions seemed to be less stable than the TexTab TX6460 solutions. The hypochlorite solutions dropped by >50% chlorine concentration after stainless steel samples had been submerged. For TexTab TX6460 solutions with the stainless steel chlorine levels remained up at 75% in the majority of cases.

Conclusion

In the case of stainless steel all grades tested seemed to be resistant to corrosion by all of the solutions tested, unless there was an imperfection in the stainless steel. When an imperfection was present corrosion was more likely but even after 30 days of submersion in the solution this corrosion was minimal.

In this study aluminum was less corroded when submerged in TexTab TX6460 solutions than in hypochlorite solutions. Hypochlorite solutions caused the aluminum to become quite corroded and the samples were no longer lustrous. In TexTab TX6460 solutions the aluminum remained lustrous and corrosion was minimal and could be removed with a bristle brush.

For additional information, please contact Texwipe Customer Service at the number listed below.

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