Process Doctor

Terry Munson

Environmental Chamber Cleanliness is Critical

The right cleaning protocol can eliminate false failures.

A quality or reliability test is only as good or accurate as the test equipment used. When performing humidity testing, results can only be accurate indicators of product performance if the interior of the testing chamber is free of contaminants. Having an effective cleaning protocol to control the testing environment is crucial to achieve valuable results. Take care in choosing a cleaner for the interior of a chamber, because many cleaners have the potential to introduce contamination into the chamber. When contaminants in a chamber deposit on boards during environmental testing, these contaminants will interact with the moisture introduced through humidity to potentially cause false failures for clean boards.

In a recent investigation, assemblies were failing 100% of the time during ESS testing on three consecutive attempts. This was a new ESS testing chamber, identical to a chamber from another facility. The only difference was that the operating environment outside the chamber was not climate-controlled; the older chamber was in a climate-controlled environment and did not present a significant amount of failures. We received boards from the failed humidity tests along with untested boards to perform ion chromatography analysis and determine the precise levels of ionic contamination. Current ROSE (resistivity of solvent extract) testing showed passing results, and very little difference between groups.

Using ion chromatography analysis, the boards showed acceptably low levels of all detected residues prior to humidity testing. These low-residue levels pose little or no risk of electrochemical or electromigration problems in a biased, high humidity environment. The 30 assemblies that underwent high humidity (90% RH) testing in a non-condensing biased environment all failed due to electromigration. Ion chromatography analysis of these boards showed very high chloride and sulfate levels of up to eight times greater than the levels found prior to high humidity exposure.

A second set of samples was submitted for testing: alcohol wiping samples from a 1 in^2 area (for 30 sec. of contact time) of the chamber door, walls, ceiling and floor. A second type of sample was a 4 in^2 piece of aluminum foil that had been placed in the chamber in the same manner the boards were placed, and was exposed to the high humidity for 24 hours. After collecting the wiping samples, running the chamber and extracting samples of the deionized feed water and steam reservoir, all these samples were sent along with a control sample of each.

The analysis of the second set of samples (foil and alcohol wiping samples) showed that a high contamination event had occurred, but the DI feed water and the steam reservoir showed low levels of contamination. The contamination was high in chloride, sulfate and amines. The amounts of chloride, sulfate and amines

all values are in µg/in^2 unless otherwise noted	Ion Chromatography						
Sample Description	**Cl^-**	**Br^-**	**SO_4^{2-}**	**WOA**	**Na+**	**NH_4+**	**K+**
Assembly prior to ESS biased humidity testing							
Sample area U5	1.24	1.32	0.26	12.36	0.26	0.89	0.11
Assembly after ESS biased humidity testing							
Sample area U5	10.27	6.39	7.59	11.08	0.34	5.69	0.08
Wiping samples of 1 in^2 areas (30 sec) prior to cleaning							
Door area	15.26	0	9.36	0	0	8.59	0
Right wall area	19.39	0	8.54	0	0	9.68	0
Left wall area	14.24	0	8.11	0	0	8.77	0
Back wall area	15.61	0	9.06	0	0	9.36	0
Ceiling area	19.22	0	10.21	0	0	9.18	0
Floor area	27.36	0	13.26	0	0	10.07	0
Control wiping (unused)	0.23	0	0.43	0	0	0	0
Foil exposed to ESS humidity chamber 24 hours	8.95	0	5.39	0	0	4.74	0
Control foil sample prior to exposure (unused)	0.06	0	0.09	0	0	0	0
Wiping samples of 1 in2 areas (30 seconds) After Cleaning with DI water and Scotch Brite (green pad)							
Door area	0.27	0	0	0	0	0.11	0
Right wall area	0.37	0	0	0	0	0.06	0
Left wall area	0.42	0	0	0	0	0.13	0
Back wall area	0.61	0	0	0	0	0.05	0
Ceiling area	0.24	0	0	0	0	0.18	0
Floor area	0.89	0	0	0	0	0.22	0
Control wiping (unused)	0.19	0	0	0	0	0	0
Foil exposed to ESS humidity chamber 24 hours	0.64	0	0.08	0	0	0.13	0
Control foil sample prior to exposure (unused)	0.03	0	0.04	0	0	0	0
DI feed water	.02 ppm	0	.01 ppm	0	.01 ppm	0	0
DI water from steam resevoir	.03 ppm	0	.03 ppm	0	.02 ppm	0	0

TABLE 1: Contaminant levels before and after chamber cleaning.

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were much higher before the cleaning of the chamber, and after the chamber cleaning, no failures occurred on ionically clean assemblies (**Table 1**).

Based on these findings, we suggested that the customer clean the chamber first by scrubbing the inside with a Scotch Brite pad with 10 MΩ deionized water, working from top to bottom. The chamber should be scrubbed three times, then wiped with DI water and a lint-free cloth over all surfaces including the vents and air inlet opening. Next, the chamber should be wiped three times with IPA using critical contact polyester wipes.

Apparently, the equipment fabricator had used a stainless steel cleaner to clean the chamber before shipment, and this residue was introducing the harmful chloride, sulfate and amine residues that caused the humidity tests to fail. The presence of these contaminants caused the ESS test results to be an inaccurate gauge of product performance. After following our recommended cleaning protocol, this customer saw results that were much more accurate predictors of product cleanliness and reliability. The first two groups after cleaning showed 0% failures with low ionic residue problems. We conducted ongoing monitoring of this chamber for several months, and the contamination problem was alleviated. This case exemplifies how important it is to maintain the cleanliness of test equipment to achieve meaningful results upon which quality decisions can be made. ■