

Case Histories in Chloride Removal Using Pliant Media Abrasive

Michael T. Merritt, President Sponge-Jet, Inc.

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CASE HISTORIES IN CHLORIDE REMOVAL USING PLIANT MEDIA ABRASIVE

Michael Merritt, President
Sponge-Jet, Inc
Eliot, Maine, 03903

ABSTRACT: This paper presents different test programs that have been performed comparing traditional dry abrasive blasting methods with certain pliant abrasive blasting methods in their effectiveness in chloride removal. Also presented is a case history at the Newark Airport where a single pass with a certain pliant abrasive blasting media lowered chloride levels from 40 $\mu\text{g}/\text{cm}^2$ to non-detectable levels in a single blast step.

Test results indicate that blasting with certain pliant abrasives is not only superior to traditional abrasive blasting but can frequently obtain chloride levels at or below 5 $\mu\text{g}/\text{cm}^2$ (which is adequate to meet most specifications) in a single surface preparation step. This process compares very favorably to other processes, which often require a multi-step procedure such as abrasive blast, water or chemical wash and final abrasive blast.

INTRODUCTION: BLISTER FORMATION

In the simplest terms, coatings are a semi-permeable membrane and thus subject to vapor transport and subsequent blistering. Formation of coating blisters is typically caused by one or more differentials across the coating. These differentials include pressure, temperature (ie., cold wall effect), electrical potential (ie., cathodic protection) and differences in soluble concentrations (ie., chlorides). Any and all of these differentials are capable of creating “osmotic drive” across the coating. This drive results in transport of water vapor through the coating (membrane), which eventually creates a blister (Fig. 1).

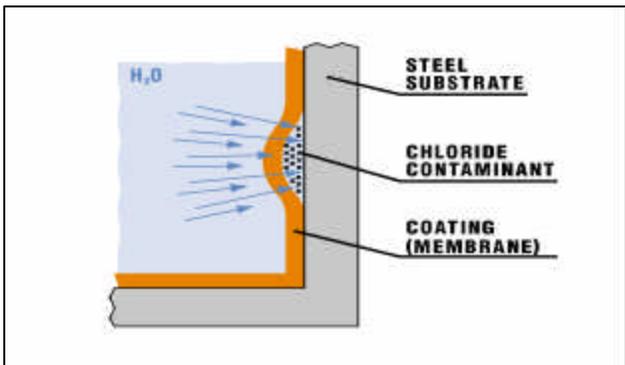


Figure 1 Photo Courtesy of Sponge-Jet, Inc.

One method to increase coating life is to reduce the “osmotic drive” in the system. In the case of chloride contaminants, which create a difference in soluble concentrations, removal or reduction of the chlorides is a prudent strategy to increased coating life.ⁱ

INCREASING EMPHASIS PLACED ON RESIDUAL CHLORIDE & CHLORIDE REMOVAL

The effect of residual chlorides on a coated substrate has been of increasing interest over the last decade due to advances in corrosion science. A greater understanding of coating performance and the correlation between the level of surface cleanliness and the expected life of the coating system has become more widely recognized.

The National Aeronautics and Space Administration (NASA) took the specification initiative, with KSC-STD-0001-D, which established it’s standard threshold for residual chlorides - five micrograms per square centimeter ($\mu\text{g}/\text{cm}^2$). The U.S. Navy began limiting the thresholds for residual chlorides in the early 1990s, which required 10 $\mu\text{g}/\text{cm}^2$ on non-immersion substrates and 5 $\mu\text{g}/\text{cm}^2$ on immersed substrates. Fewer than ten years later, the U.S. Navy lowered acceptable thresholds for residual chlorides to 5 $\mu\text{g}/\text{cm}^2$ (NFGS-09971E) on non immersion substrates and 3 $\mu\text{g}/\text{cm}^2$ (NFGS-09970F) on immersed substrates. As recently as 2000 the industrial coatings industry through SSPC, established “Non-visual Surface Preparation Definitions” which recognize three standard “Conditions” or levels of surface cleanliness. (Table 1)ⁱⁱ

Table 1 - Non-visual Surface Preparation Definitions	
SSPC SC1	Free of detectable Chloride levels
SSPC SC2	<7 $\mu\text{g}/\text{cm}^2$ Residual Chlorides
SSPC SC3	<50 $\mu\text{g}/\text{cm}^2$ Residual Chlorides

As a result, these new specifications for cleaner surfaces on which to adhere coatings, are challenging

industry professionals as well as the technologies that were employed. As more specifications for cleaner surfaces with less residual chlorides are written, surface preparation professionals are searching for ways to meet or exceed these industry specifications. While abrasive blasting certainly removes some chlorides, it does not consistently lower the residual values to specified levels during normal blasting procedures. The users of conventional abrasives often rely on water washing and re-blasting the substrate to comply with residual chloride, threshold specifications.

Other abrasive blasters are using new technologies to comply with these specifications. For example, a certain pliant media has been shown to remove more residual chlorides than traditional abrasive blasting. The first known evaluation of pliant media to remove chlorides was conducted by a high performance coating manufacturer in 1997 when qualifying the use of that process as a suitable method of surface preparation for their coatings.ⁱⁱⁱ Since that time, other tests and a variety of field applications have taken place where the technology was used to prepare surfaces and achieve chloride levels below commonly specified levels, in one step, without water, chemical washing or reblasting.

INDEPENDENT LAB TEST:



Figure 2 Photo Courtesy of ARC Composites, Division of AW Chesterton.

In 1997 the technical services department of a high performance coating manufacturer was asked by a client if a certain pliant media would be approved for surface preparation prior to use of their coatings. The coating manufacturer initiated an internal evaluation, which included contaminating metal panels in an ASTM B117

Salt Fog Chamber (Fig. 2). Measured sodium levels were approximately $400 \mu\text{g}/\text{cm}^2$. The first set of panels was blast-cleaned using aluminum oxide abrasive, washed in demineralized water, allowed to flash rust, and then subsequently blast-cleaned again. Another set of panels was blast-cleaned using a specific pliant media containing aluminum oxide abrasive.

Both sets of panels were tested using a commercially acceptable adhesive cell, chloride-measuring test kit to determine residual chloride levels^{iv}. The aluminum oxide blast-cleaned panels required two water washes, followed by abrasive blasting to achieve levels below $10 \mu\text{g}/\text{cm}^2$. The panels prepared by the specified pliant media process, achieved levels below $10 \mu\text{g}/\text{cm}^2$ without the need for washing and subsequent re-blasting.

Panels were then coated with identical film thicknesses of the manufacturer's composite lining. Both sets of panels were subject to ALTLAS closed cell test (Fig. 3), conforming to ASTM C868 using 50°C demineralized



Figure 3 Photo Courtesy of ARC Composites, Division of AW Chesterton.

water for a period of six months. At the conclusion of the test, the specified pliant media process yielded no evident blistering and was approved for use as a suitable method of surface preparation.^v

RESIDUAL CHLORIDE TEST:

One manufacturer of pliant media conducted chloride tests to determine which standard specifications could be met without conducting additional water washing or reblasting. Four metal panels were contaminated with varying levels of sea-salt water, then measured for chlorides using a commercially acceptable chloride-measuring test kit^{vi} (Fig. 4). The bottom half of the contaminated panels



Figure 4 Photo Courtesy of Sponge-Jet, Inc.

were then blasted to SSPC-SP5 “White Metal Blast” using 12/40grit coal slag and the top half of the same four panels were also blasted to SSPC-SP5 “White Metal Blast” using a pliant media with 30-grit aluminum oxide.

Residual chlorides were then measured for each section of the four test panels (Fig. 5). The results, provided in Table 2 below, revealed that in all pre-contamination levels tested, the sections blasted with the tested pliant media, consistently removed chlorides at or below 5 $\mu\text{g}/\text{cm}^2$, while the sections blasted with coal slag ranged from 9 $\mu\text{g}/\text{cm}^2$ to 20 $\mu\text{g}/\text{cm}^2$.^{vii}



Figure 5 Photo Courtesy of Sponge-Jet, Inc.

TABLE 2 - RESIDUAL CHLORIDE TEST:

Name	Panel & Sec No.	Chloride Before	Chloride After
Pliant Media #30-Grit	2.1	30 $\mu\text{g}/\text{cm}^2$	4 $\mu\text{g}/\text{cm}^2$
12/40 Grit Coal Slag	2.2	30 $\mu\text{g}/\text{cm}^2$	9 $\mu\text{g}/\text{cm}^2$
Pliant Media #30-Grit	2.3	200 $\mu\text{g}/\text{cm}^2$	5 $\mu\text{g}/\text{cm}^2$
12/40 Grit Coal Slag	2.4	200 $\mu\text{g}/\text{cm}^2$	20 $\mu\text{g}/\text{cm}^2$
Pliant Media #30-Grit	2.5	36 $\mu\text{g}/\text{cm}^2$	5 $\mu\text{g}/\text{cm}^2$
12/40 Grit Coal Slag	2.6	36 $\mu\text{g}/\text{cm}^2$	14 $\mu\text{g}/\text{cm}^2$
Pliant Media #30-Grit	2.7	60 $\mu\text{g}/\text{cm}^2$	3 $\mu\text{g}/\text{cm}^2$
12/40 Grit Coal Slag	2.8	60 $\mu\text{g}/\text{cm}^2$	12 $\mu\text{g}/\text{cm}^2$

CASE HISTORY - NEWARK AIRPORT

In March, 2001, the cooling water system at the Newark Airport was repaired and the cooling water pipes coated (Fig. 6). The New York / New Jersey Port Authority contracted a specialized turnkey coatings contractor to perform the coating repairs. The internal surfaces of the pipes required spot repairs to the existing coating and those



Figure 6 Photo Courtesy of General Magnaplate,

areas were prepared to an SSPC-SP5 “White Metal Blast” with a 3 to 5 mil (75 to 125 micron) profile.

Prior to blasting, a chloride test (Fig. 7) was performed to determine the existing levels of chloride contaminants. The test revealed levels to be 40 $\mu\text{g}/\text{cm}^2$.



Figure 7 Photo Courtesy of General Magnaplate,

Pliant media impregnated with 30-grit aluminum oxide abrasive was used to prepare the surface (Fig. 8).

Chloride levels after blasting were measured using the same test method (Fig. 9). The results revealed levels



Figure 8 Photo Courtesy of General Magnaplate, Inc.



Figure 9 Photo Courtesy of General Magnaplate,

less than the $3 \mu\text{g}/\text{cm}^2$ detectable limits of the test. ^{viii}

CONCLUSION

Both independent testing and field experience indicate that surface preparation with certain tested pliant media, provides superior cleaning as compared to traditional abrasive blasting. Furthermore, the ability to reach specified levels in a one step process is possible in the majority of applications.

ⁱ Clive H. Hare, "Blistering of Paint Films on Metal, Part 1: Osmotic Blistering," Journal of Protective Coatings and Linings and Protective Coatings Europe, (February 1998), p.53.

ⁱⁱ "Table 2 – Nonvisual Surface Preparation Definitions," Systems and Specifications: SSPC Painting Manual 2, Eighth Edition, Page 86.

ⁱⁱⁱ Arc, Division of Chesterton, Inc., Groveland, MA.

^{iv} Bresle Cell™ BC-1 Mfg. by Expertus Kemiteknik BV, Sundvall, Sweden.

^v Arc, Division of Chesterton, Inc., Groveland, MA.

^{vi} Chlor-Test™ Mfg. by Chlor*Rid International, Inc., Chandler, AZ.

^{vii} Sponge-Jet, Inc., Portsmouth, NH.

^{viii} John Kaldy, "Sponge-Jet/Chloride Reduction Newark Airport," General Magnaplate Corp., Linden, NJ, Slides 2,4,6,15.