News from the Field

Abrasive Blasting and Salt Contamination: A Case History

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The paint and protective coatings industry is only now beginning to recognize and acknowledge the detrimental effect of chloride contamination of steel surfaces. While the effects of this contamination have not yet been quantified, it is generally accepted that it adversely affects the life and performance of protective coating systems. For a comprehensive review of the literature and discussion, see Appleman, JPCL, October 1987.

Common sources of chloride include deicing salt, salt-laden air and humidity near sea coasts, salt-saturated blasting sand, salt water immersion, salt cargoes in tanks and containers, and industrial plants where chlorides are a part of the process and/or product.

There appears to be a common belief that salt is removed from a bare steel, salt-contaminated surface by the blasting action, when, in fact, blast cleaning drives some of the contamination into the pores of the steel.

Case History

A coastal utility with an extensive network of sub-surface vault transformers (500KVA and larger) has a major corrosion problem on transformer exteriors. These units are housed in concrete vaults beneath the sidewalks and streets, generally in immersion conditions. Often, salt or brackish water is present, and deicing salt from the street or sidewalks above adds to the chloride concentration.

Corrosion is the major cause of transformer breakdown, which results in power outages, a situation very unpopular with the affected customers. The utility tries to monitor these units, and as corrosion takes place and the transformer walls become thin from rusting, the units are removed (normally before the transformer fails) for repairs and are rebuilt if sufficient steel thickness remains. The removal and repair procedure is quite costly and time-consuming.

In the utility’s rebuilding shop, the first step has been to clean the transformer with steel grit in an abrasive blasting chamber. After blasting, the thickness of the steel is measured, and other evaluations are made to decide whether to repair or scrap the particular unit.
In monitoring and critiquing these procedures, the writer recommended that the transformers be steam-cleaned or pressure-washed prior to blast cleaning to neutralize the salt and other contaminants.

A KTA SCAT Kit® was used for measuring chlorides, iron salts, and pH level to demonstrate that the recommendation was valid. In this test, an area approximately 6 in. by 6 in. is marked; a measured amount of distilled water is placed in a beaker, then swabbed onto the area; and the residue is squeezed from the swab back into the beaker. The swabbing is repeated at least four times, and the swab is then placed in the beaker. A new dry swab is used to remove any surface water from the test area. This swab also is placed in the beaker, and the solution stirred for at least two minutes. A Quantab test strip is placed in the solution and left long enough for saturation. A wick portion of the tab will change color depending on the salt content.

Ferrous ion and pH test strips are also placed in the solution for readings that can be converted to iron salt and pH levels. See Figs. 1-4.

A transformer that had been immersed in salt water was identified, and an attempt was made prior to blasting to measure the salt level in the rusty steel.

Because of the roughness and porosity of the rusty steel, however, readings were difficult to obtain and results were questionable. A concentration of 0.009 percent chloride was measured, but certainly the actual concentration was greater.

Two sides of this transformer were steam-cleaned prior to blasting. Detergent was mixed with the steam and applied for approximately 15 minutes, and then clear steam was applied for five minutes. The other sides of the transformer were not steam-cleaned. See Figs. 5-7.

The transformer was placed in the blast chamber and blasted for about two hours. Immediately following its removal from the chamber, the SCAT Kit was used to test for and measure chlorides, iron salts, and pH levels. The results were dramatic.

Where steam cleaned, the surface had a neutral pH of 6; iron salts were less than 3 ppm (0.1 microgram per sq cm); and the chloride content was 36 ppm (1.6 microgram per sq cm) and/or a solution of 0.006 percent (both the lowest readings with the kit).

Where steam cleaning was not used, the pH was measured at 5 (slightly acidic); the iron salts were measured at 40 ppm (1.7 microgram per sq cm), and chloride content was higher with a value of 128 ppm (5.5 microgram per sq cm) or a solution of 0.021 percent. (For comparison, seawater has a concentration of 0.03 percent-0.035 percent).

Industry is not yet certain how much chloride contamination a particular coating system will tolerate. Certainly, tolerance will vary with the coating.
thickness and the environment to which it is exposed. Problems have been reported with chloride presence as low as 2 microgram per sq cm, and most researchers who have studied contamination agree that the maximum will be in the range of 5-10 microgram per sq cm.

The difference in the two halves of the test transformer was most obvious when SCAT tests were conducted using distilled water to measure the surface contaminants. In the steam-cleaned area (Fig. 8), the test site developed very little rust bloom after 30 minutes, whereas the non-steam-cleaned area turned bright orange within five minutes. This reaction proved dramatically that both iron salts and chlorides were still present in the area that had not been steam-cleaned prior to blasting.

Two weeks later the test sites were observed, and results can be seen in Figs. 9 and 10. It is evident that the steam-cleaned half is rusting at a greatly reduced rate. There was no rust bloom present on the non-immersion area on either half.

Conclusion

It is generally recognized that surface contaminants such as chlorides and iron salts reduce coating life and performance. This case study demonstrates that blasting alone does not remove contaminants, but that pre-washing followed by blasting significantly reduces them.

Further, this case study seems to indicate that, if not removed by washing, the contaminants are driven into the surface by the abrasive blasting action.

By removing a large portion of the chlorides, steam cleaning prior to abrasive blasting is likely to substantially improve performance of the paint system. The performance will be followed carefully to determine if the service life approaches that of the same system applied to new, entirely uncontaminated transformers.

Dow Division Initiates Use of Water-Based Epoxy Coatings

Eds. Note: The following was written in cooperation with Vernon Atwood of Dow Chemical Company and Richard House of Devoe Napko Protective Coatings.

Experimentation with water-based epoxies began at the Louisiana Division of the Dow Chemical Company in Plaquemine, LA in 1981. Presently, the major portion of the plant’s maintenance painting program has been converted to water-based epoxy primer and intermediate coatings.
According to Vernon Atwood of Dow’s Materials Engineering and Testing group, Maintenance Technical Services, an initial field test of water-based epoxies failed during exposure of the freshly applied paint in a thunderstorm. The failed coating was an early formulation that did not rapidly develop moisture resistance.

In 1983, another formulation of a water-based epoxy coating was made available to Dow for experimentation and testing. At the time, testing of coatings at Dow was done by the “in place” method—applying the coating to piping and vessels on the plant site then tracking performance.

The water-based epoxy was applied at a test site easily accessible for inspection. The area consisted of a 12 in. diameter straight run pipe, approximately 20 ft long, with elbows and valves. The surface was abrasive blasted to an SSPC-SP 5 (white metal) finish, then approximately one half of the pipe was coated with a two-coat system, a water-borne primer and intermediate coat. The remaining half of the pipe was coated with primer and intermediate coats, and in addition, a polyurethane topcoat.

The coating thicknesses were about 4 mils for the primer; 4 mils for the intermediate coat; and a 3-mil topcoat (when used), for an 8-11 dry mil for the entire system. The urethane was considered a low volatile organic compound (VOC) coating at the time, but not by today’s standards. A water test proved the coating to be moisture resistant in 30 minutes.

The water-borne coatings were applied over some existing epoxy coatings to determine adhesion, and a knife test showed good performance.

The standard coating used as a reference, according to Atwood, is a solvent-based polyamide epoxy applied over an abrasive blasted surface. In the typical performance of this standard coating, a maintenance spotblast and repaint is required four years into service.

Visual evaluations of the test area were conducted periodically. In 1986 Dow evaluated the overall performance of the water-based epoxy that had been applied in the plant in 1983. Although no maintenance had been done on the coating, it was in good condition, with no sign of chalking, cracking, or peeling. According to Atwood, the three year test period was a good indicator of coating performance under the test conditions.

**Advantages of Water-Based Epoxy Systems**

The decision by Dow to investigate the use of water-based epoxy systems hinged on three major issues: internal environmental considerations, craftsmen safety, and cost savings. By late 1986, Dow Chemical initiated an effort to be the leader in the area of reducing VOC emissions from solvents while applying coatings.

The water-based epoxy system minimized solvent emissions and reduced the need to purchase solvents to increase sprayability of high-solids coatings, and to clean up equipment. In addition, conventional spray
equipment can be used for application. According to Atwood, the pot life of the epoxy is four hours at 70 F.

Another advantage of the water-based system is that waste residue generated during the clean-up process could be reclassified as non-hazardous, due to the lack of flashpoint. According to Atwood, Dow considered the safety factor of painters during spraying and clean-up to be immeasurable. With water-borne coatings they would no longer be exposed to the possible health hazards of solvents, and the possibility of fire and explosion from solvents would be eliminated.

Dow’s Louisiana Division plans to further expand usage of the water-based epoxy system during 1988, according to Atwood.

*KTA-Tator, Inc., Pittsburgh, PA has recently made available a salt testing kit called the Surface Contamination Analysis Test (SCAT) Kit that provides a means of measuring chloride and ferrous iron, content and the pH level.

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