A VOC FREE APPROACH TO SURFACE TOLERANT COATINGS

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SUMMARY

Surface tolerant coatings have been around in the coatings market for many years. One of the main features that such a coating should have is good adhesion to surfaces with less than ideal surface preparation. The process behind this is to encapsulate any surface rust and prevent further oxidation of the metal. Also, high surface adhesion is related directly to long-term coating performance. There are certain preconceptions about these coatings in the market place that may or may not agree with the technical reality because of the many factors that can affect adhesion. We will discuss some of these factors, the SSPC-TU 1 document (Surface Tolerant Coatings for Steel) and the results of our study. We will then discuss the field performance of a new solventless surface tolerant epoxy technology. This epoxy coating has no volatile organic compounds ("VOCs"), no hazardous air pollutants ("HAPs") and contains 26% (by weight) of plant material, which is considered "bio-content". This discussion will include lab data on the adhesion of this new epoxy system over rusted steel with various surface preparations including SSPC-SP1, SSPC-SP3, SSPC-SP7, and flash rust. With the coating adhesion data, we can communicate a better performance (adhesion) to surface preparation relationship.

BACKGROUND

The term "surface tolerant" is well known when referring to coatings. What does this mean to the application? In simple terms, it means that the coating is able to be applied to an unprepared or poorly prepared surface while still retaining acceptable performance and adhesion to the substrate. Adhesion is a very good indication of coating performance, and it is fairly simple to measure. In the Society for Protective Coating (FKA Steel Structures Painting Council) ("SSPC") Technology Update No. 1 (SSPC-TU 1) surface tolerant coatings are defined as "coatings for substrates that have been prepared for painting to a lesser degree of cleanliness than provided by SSPC-SP6, 'Commercial Blast Cleaning.'"

Why would anyone want to apply a coating in less than ideal cleanliness conditions? There could be many reasons for this. It might be very difficult or expensive to properly prepare the surface. This scenario might

come into play when dealing with maintenance projects in chemical plants or offshore platforms. Since surface preparation can be very expensive, less extensive preparation could also be a cost savings.

A VOC and solvent free surface tolerant high performance epoxy coating has been formulated with proprietary curing agent technology. This epoxy coating has no volatile organic compounds ("VOCs"), solvents or hazardous air pollutants ("HAPs"), has a convenient 1:1 volumetric mix ratio and has around 26% by weight of plant based material, which is considered "bio-content". This surface tolerant coating acts as both a corrosion inhibitive coating as well as a barrier coating. This combines the two broad categories mentioned in SSPC-TU 1.

Is the surface tolerant description a realistic expectation from a coating? This is complicated as there are many variables when it comes to surface types and surface preparation that can affect the adhesion.

It is a regular industry practice that coatings manufacturers will supply a technical data sheet with information about the coating. This information includes the recommended surface preparation for their coating. This usually is SSPC-SP5 White Metal Blast to ensure the best adhesion to the steel. If the recommended surface preparation is not achieved, the coating would, hopefully, still adhere to the surface but would be expected to have a shorter lifespan. For new construction projects it is fairly easy to achieve a high quality surface preparation since one is dealing with a controlled environment and new steel. What if the coating is being used as a maintenance coating in the field and the conditions are not ideal for a true White Metal Blast? What can be done?

There are also different metals used in industrial settings. The coatings technical data sheet will list the types of compatible metal substrates. Can one be sure that the coating adheres well to carbon steel, stainless steel, aluminum and galvanized steel?

Unprepared surfaces are not the most desirable surfaces to apply coatings to since various conditions of these surfaces make it hard to be sure that a particular coating product can be applied and successfully adhere to the surface.

Some of the possible surface contaminants:

- The steel surface could have mill scale and rust. These are naturally occurring contaminants that come from the manufacturing process and the aging of bare steel. Rust is a very prominent surface contaminant and it can exist in conjunction with other contaminants.

- Previously coated steel surfaces might also be regarded as unprepared surfaces. The existing coating might still be intact or it may have failed in certain areas, causing peeling and exposing the substrate.

- Another important surface contamination to be aware of are soluble salts and chlorides. These are seen more in marine applications. Excessive amounts of these salts have been proven to cause early failure of high performance coatings.

- Surfaces can also contain greases or oils and water. These contaminants can also affect negatively the adhesion of the coating to the substrate.

STUDY

Our study started with a plant maintenance project in a pulp mill which involved the application of our surface tolerant epoxy coating. The project area was a steel structure that was exposed on a daily basis to a chlorine mist. This exposure had caused excessive corrosion and coating failure. The asset owner specified that the surface needed to be prepared to SSPC-SP5 White Metal Blast standards. The applicator communicated to the owner the surface tolerant capabilities of the coating and recommended SSPC-SP3 Power Tool Cleaning for this particular project to save the asset owner time and money. The asset owner was very cautious and asked for proof of performance before approving a lower grade of surface preparation. The applicator, with the permission of the asset owner, cut some pieces of steel from the area that needed to be coated. These pieces were then prepared per the descriptions stated in the table below and coated with the surface tolerant epoxy coating. After a week, the pieces were subjected to the ASTM D4541 Pull Off Test using a PATTI® F-16 piston. The results of this test were then compared to gauge the impact of surface preparation to the performance of the coating.

This test case illustrates how the lack of surface preparation can affect adhesion of the coating. The only variable in terms of surface preparation was the amount of rust. Since rust is one of the most common surface contaminants we believe that this data would be very useful.

RESULTS

ADHESION TABLE

Surface Preparation:	***Adhesion #1 (psi):***	***Adhesion #2 (psi):***	***Adhesion #3 (psi):***	***Average (psi):***
SSPC-SP5 White Metal Blast	**3,834**	**3,507**	**3,630**	**3,660**
SSPC-SP5 WMB with Flash Rust	**1,793**	**1,956**	**2,079**	**1,900**

SSPC-SP7 Brush Off Blast	**1,548**	**1,711**	**1,385**	**1,550**
SSPC-SP1 Solvent Clean with Rust	**2,528**	**2,528**	**2,364**	**2,470**
SSPC-SP3 Power Tool Cleaning	**3,966**	**3,947**	**3,670**	**3,860**

We were able to record more than satisfactory (> 1,000 psi) adhesion to metal in all of the samples that were tested-. The order of adhesion (greatest to least) was as follows:

SSPC SP3 Power Tool Cleaning > SSPC SP5 White Metal Blast > SSPC SP1 Solvent Clean with Rust > SSPC SP5 WMB with Flash Rust > SSPC SP7 Brush Off Blast

Adhesion reduction is as follows.

SSPC SP3 Power Tool Cleaning to SSPC SP5 White Metal Blast	5.3%
SSPC SP5 White Metal Blast to SSPC SP1 Solvent Clean with Rust	32.4%
SSPC SP1 Solvent Clean with Rust to SSPC SP5 WMB with Flash Rust	21.4%
SSPC SP5 WMB with Flash Rust to SSPC SP7 Brush Off Blast	20.3%

CONCLUSIONS

The adhesion test results confirm that the surface preparation makes a significant difference in the final adhesion of the coating. In the case of this surface tolerant epoxy coating, even the lowest adhesion yielded acceptable performance(1,000+ psi). Also noted was a reduction of 48% of surface adhesion if a SSPC SP5 WMB surface is allowed to flash rust and then painted over.

Comparing the different surface preparations in this study, it is noted that White Metal Blast and Power Tool Cleaning resulted in essentially the same adhesion numbers. As we go down the line with the other surface preparation used in this study, it can be seen that there is a reduction in adhesion from around 20-30%. This reduction appears to be significant due to the percentage drop in adhesion that was measured. When the actual adhesion values are compared, the lowest surface adhesion value measured was 1,385 psi. This amount of adhesion would be acceptable. The test proved that the contractor's recommendation of SSPC SP3 Power Tool Cleaning would give very similar adhesion as SSPC SP5 White Metal Blast. Even with this information, the asset owner still chose to specify SSPC SP5 White Metal Blast. It is the author's opinion that SSPC SP5 White

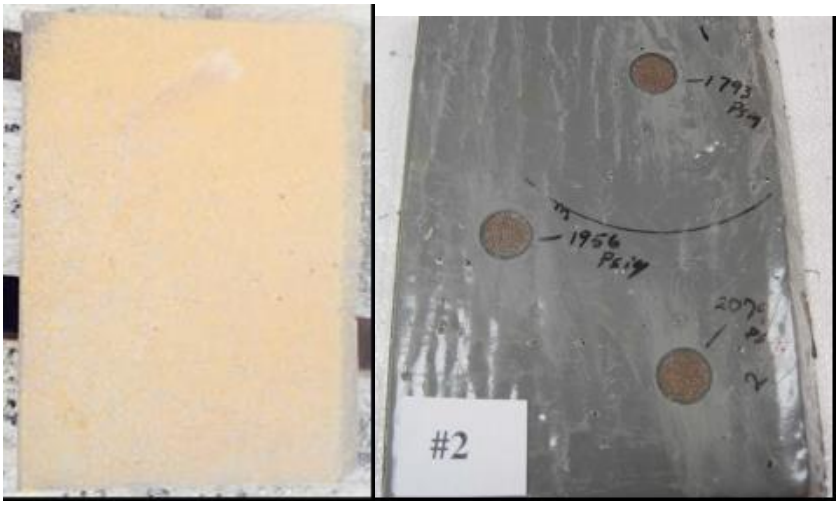
Metal Blast preparation is clearly over-specification and that the overall project cost could have been significantly decreased by lowering the- surface preparation standard. It is recommended to perform a similar study for any large maintenance project to evaluate and compare surface preparation and the capabilities of the specified coating. With these results, more informed decisions could be made that could potentially significantly reduce the project's cost.

To continue this surface tolerant study, there are other variables that should be explored to give a more comprehensive perspective. One variable is adhesion to different metallic and non-metallic substrates. The coating should be tested not only with carbon steel, but also with stainless steel, galvanized steel, aluminum and concrete. Another variable to explore would be salt contamination on carbon steel. Panels could be prepared with different amounts of salt contamination on the surface and then coated. These panels could then be exposed to salt spray (fog) testing and their performance compared. Another variable of interest would be adhesion to existing/weathered coatings. How well will the coating adhere to the original coating on the surface? This introduces another variable, which is the current adhesion of the existing coating to the surface.

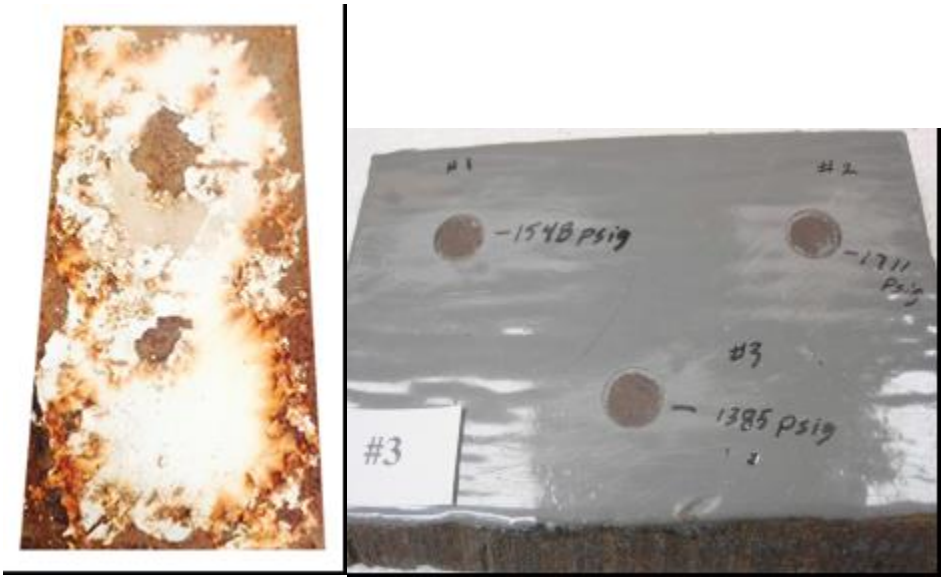
ILLUSTRATIONS

SSPC SP5 White Metal Blast

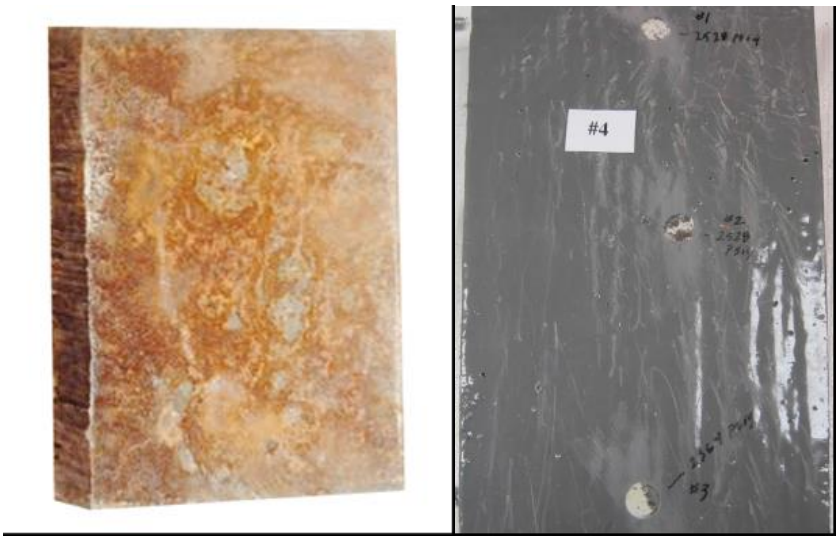
SSPC SP5 WMB with Flash Rust



SSPC SP7 Brush Off Blast



SSPC SP1 Solvent Clean with Rust



SSPC SP3 Power Tool Cleaning