

Decontamination Chemical Compatibility with Protective Coatings

Sophia Xiaoxia Zhu, Ph.D
Shell Global Solutions US Inc.
xiaoxia.zhu@shell.com

Benjamin T. A. Chang, PhD, PE, FNACE
PolyLab, Houston, TX
PolyLab@Gmail.com

ABSTRACT

Most of atmospheric coatings and tank linings for offshore fabric maintenance are routinely applied on rusted steel after dry abrasive blasting. It is well known that the salt contamination on rusted steels cannot be completely removed by dry abrasive blasting alone. Depending on the rust severity, the residual salt content on the dry abrasive blasted steel surface can be typically between 5 - 65 $\mu\text{g}/\text{cm}^2$. Recently wet abrasive blasting (WAB) has been used as the surface preparation in conjunction with the decontamination chemicals. The effectiveness of residual salts removal and prevention of flash rust with the surface preparation method combining the WAB and the decontamination chemicals was verified in our previous AMPP 2021 paper. The improved flash rust resistance combined with the possible changes of surface properties of the wet abrasively blasted steel surface may affect its compatibility with the applied coating systems, which is of great concern. The purpose of this work is to evaluate the compatibility of these decontamination chemicals with the atmospheric coatings and tank linings. The coating performance was evaluated following the ISO 12944-9 test standard. For comparison purposes, samples with a dry abrasive blast surface preparation method were also used, in addition to the WAB prepared samples. The test results revealed no compatibility issue for the atmospheric coatings and tank linings studied here with the decontamination chemicals. The rust creepage resistance of atmospheric coatings was not affected by residual chloride salt content when below 20 $\mu\text{g}/\text{cm}^2$. However, in the case of tank linings, the residual salt contamination was detrimental. For dry abrasive blasted samples with approximately 20 $\mu\text{g}/\text{cm}^2$ residual chloride salt, the immersion service performance of tank linings was dramatically affected. For the WAB prepared tank lining samples with less than 5 $\mu\text{g}/\text{cm}^2$ residual chloride salt, the immersion performance was good.

Keywords: Decontamination Chemical, ISO 12944-9, Rust Creepage, Cathodic Disbondment, Seawater Immersion, Adhesion, Wet Abrasive Blast

INTRODUCTION

Most of atmospheric coatings and tank linings for offshore maintenance are routinely applied on rusted steel after dry abrasive blasting. It is well known that the salt contamination on rusted steels cannot be completely removed by dry abrasive blasting alone. Residual salt contamination, which is hidden in the corrosion pits, is difficult to remove mechanically. Depending on the rust severity, the residual salt content on the dry abrasive blasted steel surface can be in the range of 5-65 $\mu\text{g}/\text{cm}^2$. Too much residual salt contamination can be detrimental to coating performance. It could cause coating blistering, adhesion degradation, and under film corrosion which will result in a shorter service life, particularly in immersion service such as pipeline coatings or tank linings. Recently wet abrasive blasting (WAB) has been used as the surface preparation in conjunction with the decontamination chemicals. Our paper¹ published in AMPP 2021 confirmed the effectiveness of this surface preparation method (i.e., the WAB in conjunction with decontamination chemicals to remove residual salts and prevent flash rust). The improved flash rust resistance with the possible changes of surface properties of the wet abrasively blasted steel surface may affect its compatibility with the applied coating systems, which is of great concern. The purpose of this work is to evaluate the compatibility of these decontamination chemicals with the protective coatings. Four atmospheric service coating systems and four seawater immersion tank lining systems were selected in this study. ISO 12944-9 test standard² was used to evaluate the performance of these coating systems. For comparison purposes, additional test samples were prepared with dry abrasive blasting with approximately 20 $\mu\text{g}/\text{cm}^2$ residual chloride salt in this study.

COATING SYSTEMS

The four atmospheric coatings and four tank linings tested in this study are shown in Table 1 below:

Table 1 Selected Coating Systems for Compatibility Study

Coating System	Coat	Coating Type	DFT, mil
Atmospheric Service			
Coating AT	Primer	Zinc epoxy	3-5
	Topcoat	Epoxy	6-8
Coating AI	One coat	Epoxy	10-20
Coating AJ	Primer	Polyamine epoxy	10-20
	Topcoat	Aliphatic acrylic polyurethane	2-4
Coating AC	Primer	Aluminum epoxy	7-10
	Topcoat	Aliphatic polyurethane	3-5
Tank Lining Immersion Service			
Coating TC	Primer	Glass Flake epoxy	14-16
	Topcoat	Glass Flake epoxy	14-16
Coating TJ	Primer	Phenolic epoxy	10-12
	Topcoat	Phenolic epoxy	10-12
Coating TS	One coat	Novolac epoxy	15-35
Coating TI	One coat	Polycyclamine epoxy	16-30

STEEL PANEL PREPARATION

In this study, ASTM A36 steel test panels of 75 x 150 x 5 mm (3 x 6 x 3/16 inch) were used. All panels were pre-rusted in a salt fog chamber.

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Some of the pre-rusted panels were dry abrasive blasted whereas the remaining panels were wet abrasive blasted with four different types of decontamination chemicals (DC), as listed in Table 2. The abrasive grit in both cases was garnet. The residual chloride salts after each of the surface treatments were measured as listed in Table 2. The residual chloride salt after dry abrasive blasting was higher than the WAB with decontamination chemicals. The three types of decontamination chemicals- DC-O, DC-H, DC-C were similar in their salt removal capability. The two-step decontamination chemical – DC-X (dry abrasive blast + power wash) resulted in the lowest residual salt content on the prepared surface.

Table 2 Dry and Wet Abrasive Blasting (WAB) of Rusted Steel Panels

Blast Equipment	Decontamination Chemical	Residual Chloride, $\mu\text{g}/\text{cm}^2$
Dry abrasive blast	No	15.9 ± 3.3
WAB	DC-O	3.9 ± 2.7
WAB	DC-H	3.6 ± 1.0
WAB	DC-C	3.0 ± 0.5
Dry abrasive blast + Power wash	DC-X	1.5 ± 1.1

TEST METHOD

The test methods in ISO 12944-9 standard (formerly ISO 20340) were adopted for this work. Details of the test methods are listed in Table 3.

Table 3 Coating Test Methods

Coating Property	Test Method	Test Condition
Rust Creepage (Ageing resistance)	ISO 12944-9	3 days QUV+ 3 days salt fog + 1 day (-20 °C) freezer, scribe, triplicate, 25 weeks
Seawater Immersion	ISO 12944-9	40 °C, seawater, scribe, triplicate, aeration for 25 weeks,
Cathodic Disbondment	ISO 15711	Room Temperature Seawater, -1.050 VDC, Calomel ref electrode (-1.005 VDC Ag/AgCl Ref electrode) , triplicate, 6 mm holiday, 25 weeks

Rust Creepage (Ageing Resistance)

The rust creepage or ageing resistance test was as per ISO 12944-9 for 25 weeks.

- (1) 3 days QUV, 4 hr 60 °C UV / 4 hr 50 °C condensation
- (2) 3 days salt fog, 5%w NaCl solution, 35 °C
- (3) 1 day -20 °C freezer

Pull-off adhesion test per ASTM D4541³ was conducted on test panels before and after the ageing test.