

Standardization of Wash Water Quality in Specifications for Surface Preparation

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Anything that comes into contact with a surface to be coated must be scrutinized. Abrasives, detergents, and solvents have a major impact on surface residue deposition. This article provides information on wash water quality, establishes levels of wash water quality, provides methods for testing and the interpretation of results, and discusses the inclusion of wash water quality in specifications.

“Clean water” is a nebulous term often used in surface preparation. Though found in many standards, it is neither clearly defined nor defined in any glossary. The SSPC-TR2/NACE 6G198¹ joint technical report, “Wet Abrasive Blast Cleaning,” Part 4.3.1, states that the purity of water can affect the quality of the cleaned substrate and that there is no current definitive number for acceptable levels of water purity.

NACE No. 5/SSPC-SP12,² “Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh-Pressure Water Jetting [HPWJ and UHPWJ] Prior to Recoating,” refers to water cleanliness: “Water used in water jetting units must be clean and free of erosive silts and other contaminants that damage the pump valves and/or leave deposits on the surface being cleaned.” Taken literally, the standard states that any amount of contaminant in the water would leave a deposit on the surface being cleaned and that pure water would be the required standard. Taken in the spirit of the document, “some” contaminants would be allowed in the wash water.

Not all water is the same. Cleanliness differs greatly among pure water, potable water, and recycled water. Though the salts in wash water have a direct impact on surface cleanliness, water quality (WQ) has been unrecognized, underplayed, or ignored. Such inattention is counterproductive to surface cleanliness. Standardizing water quality would allow specifiers to control surface contamination and/or decontamination more precisely and increase the potential for longer coating service.

What, then, is considered clean water with regard to surface preparation? Answering this question requires a basic understanding of water and salt.

Pure Water

Pure water (H₂O) is a transparent, odorless, tasteless, and almost colorless liquid with a pH of 7 when free of impurities. The faint blue or blue-green color of water is apparent only in deep layers.³ Any odor or taste in water stems from impurities such as dissolved mineral matter, dissolved liquids, or even dissolved gases.⁴ A non-electrolyte pure water does not conduct electricity.⁵

Potable Water

The Protective Coatings Glossary, SSPC 00-07,⁶ defines potable water as

“Water that is fit for human consumption; mainly drinking water.” Potable water may not be fit for surface preparation, however. It may be a very good electrolyte containing varying amounts of dissolved ionic “impurities.” Ions (cations and anions) are electrically charged and can readily move through a solution, carrying the electrical charge with them. When electrodes or electrical connectors are in the solution with the ions, the cations move toward the negative electrode (cathode) and the anions move toward the positive electrode (anode).⁴ This movement and attraction in solution on a steel surface explains how small amounts of impurities (salts) in wash water may attach themselves to the steel being cleaned, thus providing another avenue of salt deposition onto a surface.

Most potable water in the U.S. is treated with various amounts of biocide(s)—typically sodium hypochlorite (NaOCl) (chlorine), bromates, chloramines, chlorites, etc. The U.S. Environmental Protection Agency (EPA) (Washington, D.C.) “National Secondary Drinking Water Regulations,”⁷ under “Guidance for Nuisance Chemicals,” suggests a level of no more than 250 ppm for chlorides, 250 ppm for sulfates, and a maximum of 500 ppm for total dissolved solids for human consumption. The EPA’s primary potable water regulations also allow no more than 10 ppm nitrates, measured as nitrogen.

However, these maximum levels of salts neither reflect an ability to clean a surface nor echo their potential destructive forces to a metal surface when used in surface preparation.

Factory (Plant-Industrial-Fire) Water

The quality or cleanliness of industrial and fire water may vary from distilled water to deionized water to reverse osmosis (RO) water to recycled cooling tower water, etc. The quality

TABLE 1

CONTAMINATED WASH WATER DEPOSITION VERTICAL STEEL SURFACE WITH 2.5- TO 3.0-MIL PROFILE

Chloride, sulfate, or nitrate =	30 ppm	60 ppm	90 ppm	150 ppm	180 ppm	300 ppm
Expected deposition ($\mu\text{g}/\text{cm}^2$)	0.25	0.5	0.75	1.25	1.5	2.5

of factory water may not have a required cleanliness criterion, and usually it is unfit for consumption. Outages and maintenance breakdowns, however, may cause the quality to vary—even if a cleanliness criterion is established.

Impurities in Natural Water

Natural water contains many dissolved and suspended materials. Rainwater contains dissolved gases (oxygen, nitrogen, and carbon dioxide [CO_2]), air pollutants (chlorides, sulfates, and nitrates), suspended dust particles, and other particulate matter.

According to EPA reports, rain water has a pH ranging from 4.3 to 6.0.⁸ Any rain having a pH of 5.6 or less is considered acid rain. Ground water contains minerals dissolved from the soil and some suspended matter. Seawater contains more than 3.5% dissolved matter, most of which is derived from sodium chloride (NaCl).⁴

Deionized, Distilled, and RO Water

The Protective Coatings Glossary defines deionized water as “water purified by passing it through ion exchange resins to remove the mineral salts.”

Distillation is a process of heating water in a distillation vessel. The liquid is converted to a vapor that passes over into the condenser. The vapor is condensed to a liquid, which flows into a receiving vessel. The dissolved mineral matter such as salts, etc. are not volatile at the boiling point of water and remains behind in the distillation vessel.⁹

RO, sometimes referred to as hyperfiltration,¹⁰ is a process of forcing pressurized water through a semi-

permeable membrane: some matter is allowed to pass through the membrane and some is not.

Testing Water for Salts

There are numerous commercially available field test kits for testing water. Some test only for chlorides and others for chlorides, sulfates, and nitrates. Conductivity is another method that tests for “total” conductive species. Any method has advantages and disadvantages and must be understood prior to inclusion in a specification. SSPC Guide 15/SSPC TU-4¹¹ describes various methods for testing extract solutions and could be used for testing water.

Evaporation With Subsequent Salt Deposition

It must be remembered that during the surface-washing phase, and until evaporation occurs, the surface is considered to be immersed.

Mitschke¹² states: “When a steel plate is power washed with water containing dissolved salts, a thin film of water will remain on the steel, evaporate, and leave a residue of these salts on the steel. Using a gram-sensitive scale, it has been estimated that 0.25 micrograms chloride/square centimeter ($\mu\text{g}/\text{cm}^2$) can be deposited onto a vertical steel surface with a 2.5- to 3-mil [63.5- to 76.2- μm] profile that is washed with water containing 30 ppm chloride. If the water contains 250 ppm chloride, the deposition of chloride will be $\sim 2 \mu\text{g}/\text{cm}^2$. Increased surface profile would be expected to allow more water to adhere than lower surface profiles. On horizontal surfaces, the thickness of the water film can be even greater, resulting in a higher level of chloride deposition.”

TABLE 2

WATER QUALITY (WQ) (PPM)

WQ 1	WQ 2	WQ 3	WQ 4	WQ 5
0	>0≤30	>30≤60	>60≤90	>90≤150
WQ 6	WQ 7	WQ 8	WQ 9	WQ 10
>150≤200	>200≤250	>250≤300	>300≤350	>350

Wash Water Deposition Rates

Table 1 shows the expected salt deposition left on a vertical steel surface with a 2.5- to 3-mil profile after water washing and evaporation at various salt levels, based on the Mitschke research.

Wash Water Standard (WQ)

Table 2 shows suggested WQ numbers for specifying “cleanliness” of wash water with regard to chlorides, sulfates, and nitrates (total of the three) based on the expected salt deposition from Table 1.

Additive Effect

A review of published literature indicates the additive effect of the various salts has not been established. The literature does indicate higher corrosion rates with increases in salt density, however.¹³

Flash Rust

These WQ levels do not necessarily correlate to flash rusting from one job environment to another. A review of published literature gives no indication of salt levels on steel at various humidity, dew point, and temperature levels at which flash rusting does or does not occur.

In NACE 5/SSPC-SP12 under ^(A)Note: it states, “HP WJ [high-pressure water jetting] and UHP WJ [ultra-high-pressure water jetting] surfaces do not exhibit the hue of a dry abrasive-blasted steel surface. The matte finish color of clean steel immediately after WJ will turn to a golden hue...” This visual hue is iron oxide (FeO) (rust) caused by the water and/or salt, and it can be clearly seen under magnification.

Recycled Wash Water

The reuse or recycling of water will “accumulate” various contaminants and is typically filtered or treated before it is allowed to reenter the pump system. Many pump equipment manufacturers require filtration through a 5-µm or smaller filter to preserve pump valves and seals. A 5-µm filter is not sufficient to remove salts, however; a ~0.001-µm filter is needed to remove most salts.¹⁰

Water Usage With Salt Removers and Passivators/Inhibitors

It is becoming more common to use chemical salt removers and passivators/inhibitors when water washing for surface preparation. The most cost-effective dilution of a salt remover and passivator/inhibitor would be to use water of sufficient cleanliness that the active ingredient(s) in the chemical would not be impacted by the impurities in the water.

Water Usage With Abrasives

Spark and dust control on many projects during surface preparation may be of utmost importance. Adding water together with abrasives typically reduces or eliminates sparks and dust.

In the past few years, several water-soluble abrasives have become available. When used in combination with water during surface preparation, the deposition of soluble residue onto the surface must be carefully monitored because the soluble salt deposition after blasting may be above the specification limits, requiring remediation.

Field Methods for Cleaning Water

RO may be the most economical method of “cleaning” wash water, but the system needs sufficient volume to accommodate the workload. Deionized mineral tanks also are readily available, but the cost per gallon (3.8 L) treated is greater than RO. Sometimes RO units are installed upstream of the deionization tanks, allowing the tanks to finish “polishing” the water more cost-effectively. Other methods may be employed, but the result in any case should give the required cleanliness and be economically feasible.

Preparing a Specification

A written specification typically would identify a field test kit or method for testing and quantifying salt contaminants in the wash water. Also, generally it would define an acceptable level of each salt (or conductivity) and present suggested remediation method(s) for noncompliant wash water. It would normally state whether water recycling is allowed. The author suggests the following verbiage:

“Water used for surface preparation shall be tested for chlorides, sulfates, and nitrates using the...field test kit and shall meet the following requirements: chlorides shall not exceed 10 ppm, sulfates shall not exceed 40 ppm, and nitrates shall not exceed 10 ppm. The total of these salts shall not exceed 60 ppm. (Wash water quality shall be WQ 3 or cleaner). If the water requires cleaning to meet these criteria, it shall be cleaned using RO and/or DI methods prior to use. Recycling wash water is allowed, but the cleanliness requirement must be maintained.”

Conclusion

Despite the disparity of adequate wash water values, and until such values are implemented and standardized, imaginative engineering offers the opportunity to greatly improve control of wash water cleanliness.

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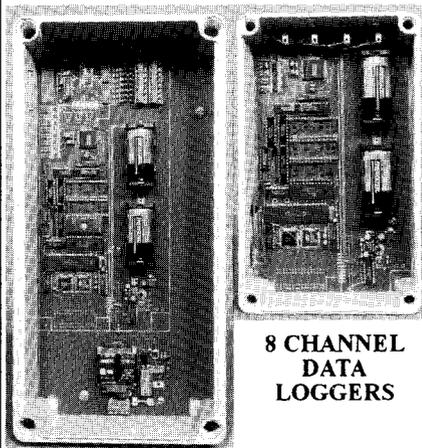
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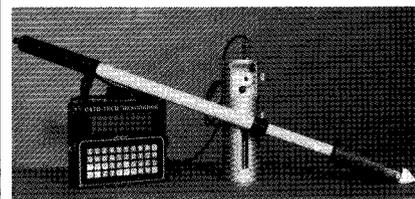
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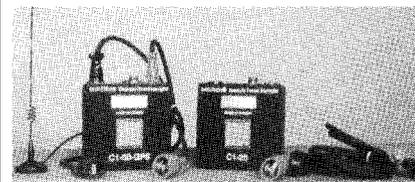


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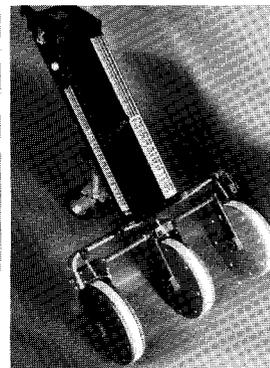
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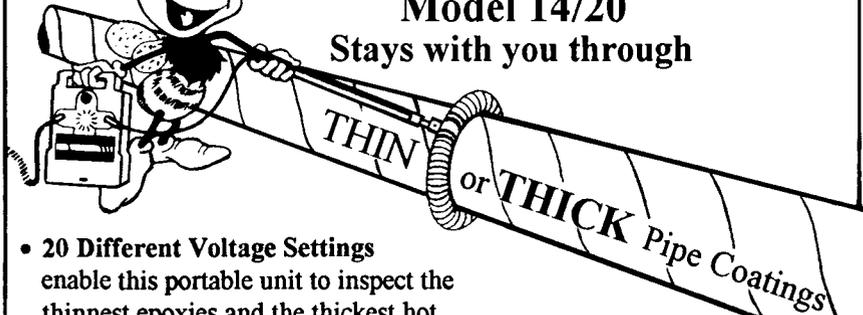
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