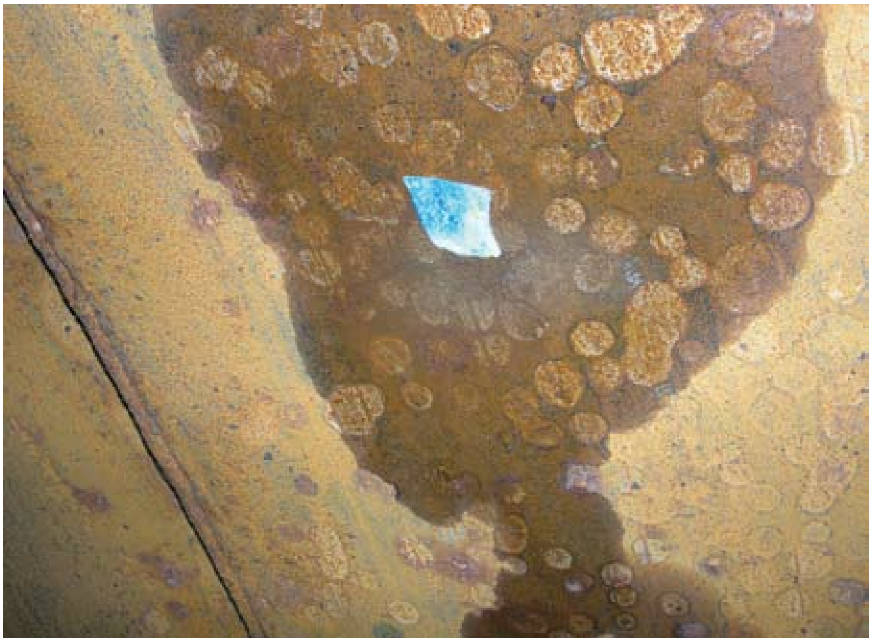
Removing Soluble Salts

By James R. Johnson

Soluble salts are at the forefront of discussion in the coatings industry, but are often overlooked in specifications. In an effort to provide the industry with comprehensive information about soluble salts and corrosion prevention, CoatingsPro *and CHLOR*RID are pleased to present the final article in a series of articles, "Salts 101."*



ABOVE ▲ Often a coatings specification for a steel substrate will call for surface prep using Ultra High Pressure Water Jetting (UHP-WJ). However, salts that have attached to and reacted with a metal substrate sometimes cannot be removed even with 40,000 psi UHP-WJ. Once these chloride ions form an attachment to the metal substrate, a very high level of energy is necessary to break that electro-chemical bond.

How Do You Remove Salts?

Removal of soluble salts can range from very easy to extremely difficult, depending on actual conditions which can vary greatly. Consider just one very common salt — sodium chloride. The chloride ion is never found by itself. As it is commonly encountered in the coatings industry, the chloride ion is always coupled with something else. For chemical stability, the chloride ion (this also applies to sulfate and nitrate ions) seeks to attach to something, forming compounds such as sodium chloride, zinc chloride, lead chloride, ferrous chloride, or any of several other combinations.

When a coated surface becomes contaminated with sodium chloride, the salt lies on the surface. Due to the chloride ion's strong affinity for metals and its extremely small size (1 μg of $FeCl3$ = ~ 3,686,600,000,000,000 molecules), even very small imperfections — such as nicks, scratches or micro cracks — in the coating allow the ion to migrate to the metal surface. At the metal surface, with the chloride ion having its affinity for metals, it leaves the sodium and bonds with the metal surface for greater stability. The chloride ion forms an electro-chemical bond to the metal and that bond becomes extremely strong. That is why it cannot be simply washed off with a garden hose. Where the sodium chloride would have been relatively easy to remove from the surface of the coating, the chloride ion now has bonded with the metal surface and is far harder to remove. For example, most of the salts on the surface of a coating can be removed with low-pressure water blasting, but salts that have attached and reacted with the metal substrate sometimes cannot be removed with 40,000 psi Ultra High Pressure Water jetting (UHP-WJ).

> **The coating manufacturers should be asked not only what the allowable level of salts is, but they should be asked what the allowable level is to attain an intended or targeted lifespan.**

Once these chloride ions form an attachment to the metal substrate, a very high level of energy is necessary to break that electro-chemical bond. That energy can be in the form of mechanical energy, chemical energy, or both. The properties of mechanical energy are widely known, but many coating professionals are unaware of the ability or chemical requirements of a salt remover. Since it was a series of reactions that resulted in the bonding of the salt anion to the steel substrate, chemical disbondment is the most effective method and has the highest probability of success of removal if the proper product is used.

Chemical salt removal is not new to portions of the coating industry. Pipe coating operations have been utilizing a phosphoric acid bath for several decades for salt removal. For maximum effectiveness, a salt remover should have several distinct properties:

1) The pH of the remover should be below 7 to facilitate disbonding, as supported by both chemistry textbooks and history. Products with a pH above 7 accelerate the formation of a barrier layer which can mask salts remaining on a surface.
2) The remover should be capable of being used with water that contains a fairly high level of salts, such as 600 ppm of chlorides, as is common with many water sources.
3) It should not leave any type of residue that will interfere with adhesion of coatings.
4) It should not leave any film that will interfere with the adhesion of a coating.

As has been stated, the mechanical energy of pressurized water alone sometimes cannot do the work, but when combined with the chemical energy of a salt remover the work can be accomplished successfully. One form of energy assists the other, thereby providing the needed energy to complete the task.

On an abrasive-blast-cleaned surface, chlorides can usually be adequately removed with the mechanical energy of a 3,000 psi pressure washer with a salt remover added, providing the chemical energy needed to perform the task. The water pressure is important for penetrating the crevices of the surface profile that exists on abrasive blasted metal surfaces — in joints and connections and similar locations and for flushing the disbonded salts from the surface. The action of a chemically balanced salt remover will take on the challenge of disbonding the chloride ion from the metal while the water flushes it off.

RIGHT When confronting the problem of soluble salts, it is important to remember that soluble salts are not only found in marine environments or in areas where de-icing salts are used. Industrial emissions transform to acids, which can in turn convert to surface salts.

When discussing water on bare steel, the subject of flash rust invariably arises. Reviewing what was stated in an earlier article ("Notes From The Field," May 08), contaminants, including minerals, cause flash rust, so when the contaminants are removed the cause of flash rust is removed.

Note: Since it is uncommon to totally remove all contaminants from all surfaces, there usually are some very low levels of salt contaminants remaining after decontamination. This is because of the irregular structure of a metal surface after abrasive blasting. When an abrasive blasted surface is viewed under magnification, it can be seen that the abrasive has impinged onto the surface, forming the valleys and peaks of the profile. Also visible at the same time is that succeeding abrasive grit has burred over the peaks and even created cave-like formations where one peak burrs over and meets another. To remove 100 percent of these incredibly small ions from such locations can be almost impossible. Even a very small amount of contamination can cause some flash rust, but it is typically very minimal and in many cases reblasting is not necessary. Some manufacturers of coatings, primarily for immersion service, do require a full white metal surface with no flash rust. In this case, it is usually necessary to perform a light sweep blast to remove any small amount of flash rust or use an approved inhibitor, or passivator product.

Dry and Wet Blasts: Which To Use And When?

There are several methods available to remove salts; only one is a dry method; the others all include the use of water. The dry method involves repeated abrasive blasting. A fine grit abrasive blast media is more effective at removing salts than coarse grit, so an engineered abrasive mix is sometimes specified (coarse abrasive to provide the necessary profile and fine abrasive for cleaning). But seldom can an effective job of removal be accomplished in a single abrasive blast. Typically, a surface has to be abrasive blasted, allowed to rust back and then reblasted. It is not unusual to reblast a highly contaminated surface multiple times to reach an acceptable level of cleanliness, particularly on highly contaminated surfaces such as those found in marine environments, pump bodies, and water inlets. The rust-back process can be activated by atmospheric humidity or hastened by a water wash; simply add moisture and the salts will do the rest. The costs associated with such an operation make this an economically questionable process.

Of the wet methods, there are several choices, such as UHP-WJ, wet abrasive, or slurry blasting, and dry blasting in conjunction with a water wash with a salt remover added, which sometimes requires a reblast as stated above. Other less common methods exist, such as specialty abrasives, but a particular type of abrasive alone will probably not remove all salts, though some abrasives

LEFT ◀ All liquid-applied coatings are moisture-vapor permeable and will allow the salt on a substrate to "draw" moisture through the coating, causing the active corrosion of the substrate long before the coating fails.

do "scrub" the surface better than others. Reviewing the various options available, it can be determined which method will work best for a particular job.

UHP-WJ can, but not always, result in the desired level of cleanliness. If you want to be assured of attaining the desired cleanliness levels on a first time basis, add a suitable chemical salt remover to the water. This combines both mechanical and chemical energies, each assisting the other. This also allows the operator to proceed as fast as the visual work can be performed while being assured the non-visible contaminants will be removed. Maximum production can be achieved in this manner.

Wet abrasive blasting, or slurry blasting, can reduce chlorides, but may not attain the desired result in a single blast. A suitable chemical salt remover can be added to the water, thereby combining chemical energy with mechanical energy. In every reported case using a low pH chemical salt remover, this method has resulted in chlorides being reduced to a non-detectable level with a single blast. A brush blast may be required to remove light flash rust, usually quickly and easily accomplished, or an inhibitor may be used in the rinse down water.

Wet abrasive blasting is not used frequently because "old habits die hard" and contractors are accustomed to dry abrasive blasting. Many contractors say that they do not want to make major equipment investments, not knowing the task can be accomplished with something as simple as a water ring, usually costing under $100.00, or an injector type nozzle, costing just slightly more, installed on their existing blast equipment. Wet abrasive does not sweep easily, but it can be vacuumed or shoveled much the same as dry. This method does offer greatly increased visibility, which is a major consideration. Because wet abrasive blasting is almost dust free, environmental compliance is far less an issue. Since operators have better visibility, additional blast nozzles can be operated to complete a job more quickly. Because dust is not generated, time and labor savings result with a cleaner surface for coating adhesion.

The technique most commonly used is a dry abrasive blast of any rusted areas, sufficient to remove rust to an exposed bare steel substrate, such as would be provided by an Industrial Blast Standard. Depending on the extent of rusting, this could be either a spot blast or a complete blast over the entire surface. This blast is

RIGHT ▶ It all hinges on information. For information regarding the requirements of a coating system it is traditional to go to the coating manufacturer. Since they know their product best, they are the most able to provide guidance on allowable salt levels. To gain meaningful information, the coating manufacturer should be asked not only what the allowable level of salts is, but they should be asked what the allowable level is to attain an intended or targeted lifespan. Tying the lifespan requirement into the equation will result in much more meaningful input — and fewer premature coating failures due to soluble salts.

merely to remove any barrier materials, such as rust or damaged coating, and to provide access to the salts so they may be removed. A pressure wash is then performed, usually a minimum of 3,000 psi, with a salt remover added to the water, again providing a combination of mechanical and chemical energy for removal. A final blast is then performed to the standard required by the specification. This same technique can also be performed by first dry abrasive blasting to the standard required, and then performing the pressure wash with the salt remover, followed by a brush blast to remove any excessive flash rust or a rinse with an approved inhibitor. Either method works well and can be relied on to achieve the desired result if performed correctly. These methods are very cost effective and do not cause problems to cleanup, workers, or the environment. Each of the above is uniquely different and as each job is different, the option may be chosen that will provide the best result for each specific project.

Allowable Levels Are The Question

The entire coating industry is asking for guidance on allowable levels of salt contamination. Though many have voiced their opinions — some very loudly — almost all are people who will not bear the cost of a premature failure. The old adage seems to apply here — “Advice is cheap.” If advice is not correct, the advisor seldom is held responsible for the results. For information regarding the requirements of a coating system it is traditional to go to the coating manufacturer. Manufacturers provide requirements for profile, mil thickness, recoat windows, etc. Since they know their product best, they are the most able to provide guidance on allowable salt levels. In order for them to do this effectively, they need to be informed of the intended project lifespan. To gain meaningful information, the coating manufacturer should be asked not only what the allowable level of salts is, but they should be asked what the allowable level is to attain an intended or targeted lifespan. Tying the lifespan requirement into the equation will result in much more meaningful input. Proceeding in this manner should provide the best answer to the question.

Our industry is changing. We, as a group and as individuals, are faced with change and challenge in order to keep up with technology. While we have relied on visible standards for surface preparation, we need to recognize that we must also be concerned about non-visible contaminants. This requires specific testing. To avoid premature failure of coatings, excessive soluble salt contaminants need to be removed. CP

JAMES R. JOHNSON has over 20 years experience in the fields of protective coating sales, application, and inspection. He served as a two-term Chairman of NACE STG-04 Surface Preparation Committee; Chairman of TG-142 joint NACE/SSPC task group on Decontamination of Contaminated Surfaces; and as Vice-Chairman of TG-288, NACE Task Group, Designating Non-Visible Contaminant Levels. He is a member of the joint NACE/SSPC task group on Wet Abrasive Blasting, as well as a member and previous Chairman of SSPC C.2.7 Soluble Salts Committee.

*The information provided in the series is a synopsis of materials presented at CHLOR*RID International, Inc.’s Soluble Salt Training Sessions. Additional educational and informational materials are available online at www.chlor-rid.com. For more information, call (800) 422-3217 or e-mail info@chlor-rid.com.*

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