**Soluble Chlorides in Abrasive Media**

**Answer**

*From John W. Peart, Federal Highway Administration, McLean, VA.*

The residual salt content of blasting abrasives and their effect on the performance of coatings applied to steel substrates has been studied extensively by the National Shipbuilding Research Program (NSRP), the Federal Highway Administration (FHWA), and other interested investigators.

The level of ionic contaminants in natural abrasives (i.e., silica sand, zirconium sand, and garnet) is dependent upon the original soluble salt contamination and the thoroughness of the producer’s washing process.

Smelter slags (i.e., nickel and copper), and furnace bottom or coal slags can be either air- or water-quenched. Coal slags are most often water-quenched. The purity of the quenching water and the cleanliness of the quenching basins have a significant effect on the cleanliness of the abrasive product.

Coal-fired electric power generating facilities, the major source of raw materials for coal slag, may use slag-quenching basins as receptors for other solid wastes, such as fly ash, stack waste, or scrubber residues, which subsequently may be incorporated as contaminants into the molten slag when it is quenched. In addition, these wastes may transfer ionic contaminants to the quenching water and then to the abrasive if the slag is not adequately washed before it is crushed.

Abrasive may also be contaminated with soluble salts due to the salinity of the quenching water. In the past, electric power plants along the coast have used tidal ponds as a source of quenching water. The use of this water resulted in abrasives with high chloride levels.

Soluble salts can also contaminate abrasive that is transported by a ship and used as ballast in tanks that normally carry salt water. Persons applying coatings outside the U.S. where abrasives are imported should be aware of this practice.

Abrasive salt contaminants are easily transferred to steel substrates during blasting, and surprisingly small quantities of chloride (10 µg/cm²) may initiate underfilm corrosion or osmotic blistering in organic barrier coatings. Literature indicates that higher levels of chloride contamination may be required before coating degradation occurs in less severe atmospheric exposures. One investigator reported good performance in 7 out of 10 coatings applied over 100 µg/cm² chloride and exposed for 4 years in an industrial atmosphere.

The 3 inorganic zinc coatings performed well at chloride levels of 500 µg/cm². FHWA research has verified that inorganic zinc coatings can tolerate chloride. Investigators worldwide have found that coatings are much less sensitive to sulfate contaminants than chloride salts.

Fortunately for the user, ionic abrasive contaminants can be easily and accurately determined in the field by using a low-priced field conductance tester. Using the tester in conjunction with ASTM D 4940, Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives, provides a fast and reproducible way to determine the degree of ionic contamination in the abrasive.

In the procurement documentation, the user should document the level of ionic contaminants acceptable or reference a material specification that does so, such as MIL-A-22262A(SH) or SSPC-AB 1, Mineral and Slag Abrasives. This will eliminate a variable that can adversely affect the performance and durability of the coating system.

**References**


The question continues...

Answer
From David Hale,
Ervin Industries, Inc.,
Ann Arbor, MI.
Yes, blast cleaning abrasives can contain chlorides and other soluble salts. SSPC did a study, “Effect of Surface Contaminants on Coating Life,” SSPC 91-07, for the Federal Highway Administration. In this study, more than 20 abrasives were tested for levels of contaminants. Soluble salt levels ranged from 24 to 1,300 microsiemens.

According to the data and the conclusions of this testing, the salts cannot be transferred to the steel surface during blasting in sufficient amount to cause coating performance problems. Test panels were cut from A-36 steel with intact mill scale. These panels were blast cleaned with the abrasives with the various levels of contamination. Three different methods were then used to extract and measure the levels of soluble salts that were deposited on the panels during blast cleaning. Plate extract contaminant levels ranged from 2.4 to 41 microsiemens, depending on the measurement method.

I sorted the data by increasing lev-
els of conductivity of the abrasive used for blasting (Table 10 of SSPC 91-07). Plate contaminant levels did not correlate with the levels of contaminants in the abrasives. I plotted the data in 3 charts in SSPC 91-07, all entitled “Conductivity of Plate Extract versus Conductivity—Abrasive Extract.” The conductivity of the abrasive extract showed no relationship to the conductivity of the plate extract, as measured by all 3 methods of extracting the contaminants from the plates. Therefore, we must conclude that there is no relationship between abrasive contaminant level and blast cleaned surface contaminant level.

Panels blast cleaned with the various abrasives were coated using 3 different coating systems and tested in immersion—a very severe test. To quote the SSPC 91-07 report, “these data substantiate a recent report that abrasives are not a significant cause of early coating failure in immersion,” and “this analysis demonstrated that very low levels of contaminants are transferred and are barely detectable” (p. 46). Data and charts plotting conductivity of the plate extract and of the abrasive extract are available from SSPC.

Answer
From James D. Hansink, Emerald Creek Garnet Co., Fernwood, ID:
There are really 2 questions here: “Is it possible?” and “Should I care?”

The simple fact is that chloride and other soluble anions are quite common in the natural environment, and it is easy to measure them in very low concentrations. In addition, it is easy to see and to understand that iron rusts in the presence of water and chloride ions. This information invites the search for a causal relationship between possible sources of chloride contamination and possible corrosion or coatings failure.

Some abrasives carry significant amounts of soluble chloride. In recognition of the potential problems that this might raise, the U.S. Navy set a limit of 0.03 percent (300 ppm) for chloride when it developed its ship hull blasting specification (MIL-A-22262) in 1987. The Navy limit was somewhat arbitrarily set at this level because it was perceived to be well below the level at which problems are typically encountered.

Many observers have pointed out that mineral slag abrasives quenched in sea water during formation contain higher than average chloride levels. These same abrasives are
often reported to be associated with flash rusting and other problems.

For example, 2 copper slags were used to blast steel test coupons, and both had very different chemical characteristics. The panel blasted with Slag A flash rusted. The rust contained 0.02 percent soluble chloride and 0.09 percent sulfate. It had a conductivity rating of 25 µmho/cm and a pH of 5.5. The panel blasted with Slag B did not rust at all. It showed less than 0.01 percent soluble chloride and sulfate. The conductivity rating was 5.4, and the pH was 7.0.

There are several possible explanations for the intense flash rusting on the steel blasted with Slag A; however, it was probably the chloride, in conjunction with the soluble sulfate, that caused the surface to rust.

Chloride pervades our lives in a number of forms. Focusing on abrasives as a possible source may be overkill. I’ve often wondered why we worry about how many parts per million is too many, and then throw 3 or 4 tons of salt on a bridge to melt ice.

The significance of the soluble chloride on an abrasive must surely be related to the efficiency of the transfer mechanism—the amount of chloride that is transferred from the media to the steel during blasting. A low transfer rate would argue against setting extremely low limits. In addition, the efficiency of transfer probably is determined by a number of variables (i.e., pressure, grain shape, or condition of the blasted surface), so it would be difficult to predict.

European workers have reported that the amount of chloride transferred to the steel is generally proportional to the amount on the grain. If this is true, it would argue for the use of abrasives with the lowest practical (not lowest possible) chloride level. In response to this concern, the International Standardization Organization set an allowable level of 0.0025 percent (25 ppm) in its abrasives standards. However, there is little or no direct evidence to suggest that this strict limit is warranted.

There is little doubt that abrasives with high levels of soluble ions cause flash rusting and other problems. The precise mechanism and the precise role of chloride are not clearly understood. Detecting and measuring chlorides are easy and inexpensive tasks, but relying on these measurements and excluding other likely causes of coating failure would be shortsighted. In this author’s opinion, the level of risk appears to be minimal for abrasives that contain less than 0.01 percent (100 ppm) soluble chloride. Most good quality blast media contain less than 0.0025 percent (25 ppm), so selection should not be limited.

The buyer can easily request that the supplier provide a certified analysis showing the chloride level on the material. One should realize that the chloride (or sulfate) found at the job site may not be related to the abrasive in use. While we are worrying about the significance of the difference between 24 ppm of chloride and 26 ppm of chloride, we should keep in mind that the ocean water next to the dry dock contains 19,000 ppm of chloride and the salt on that bridge in New York or the street in Denver contains 607,000 ppm.

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The discussion about the question will not necessarily stop at the time the answers are published, however; for at the end of the “Forum” each month, readers’ comments regarding the answers provided to previous questions will be published under the heading, “Reader Response.” In this way, JPCl will promote a long-term exchange of ideas and opinions regarding problems faced by the users of protective coatings and linings.