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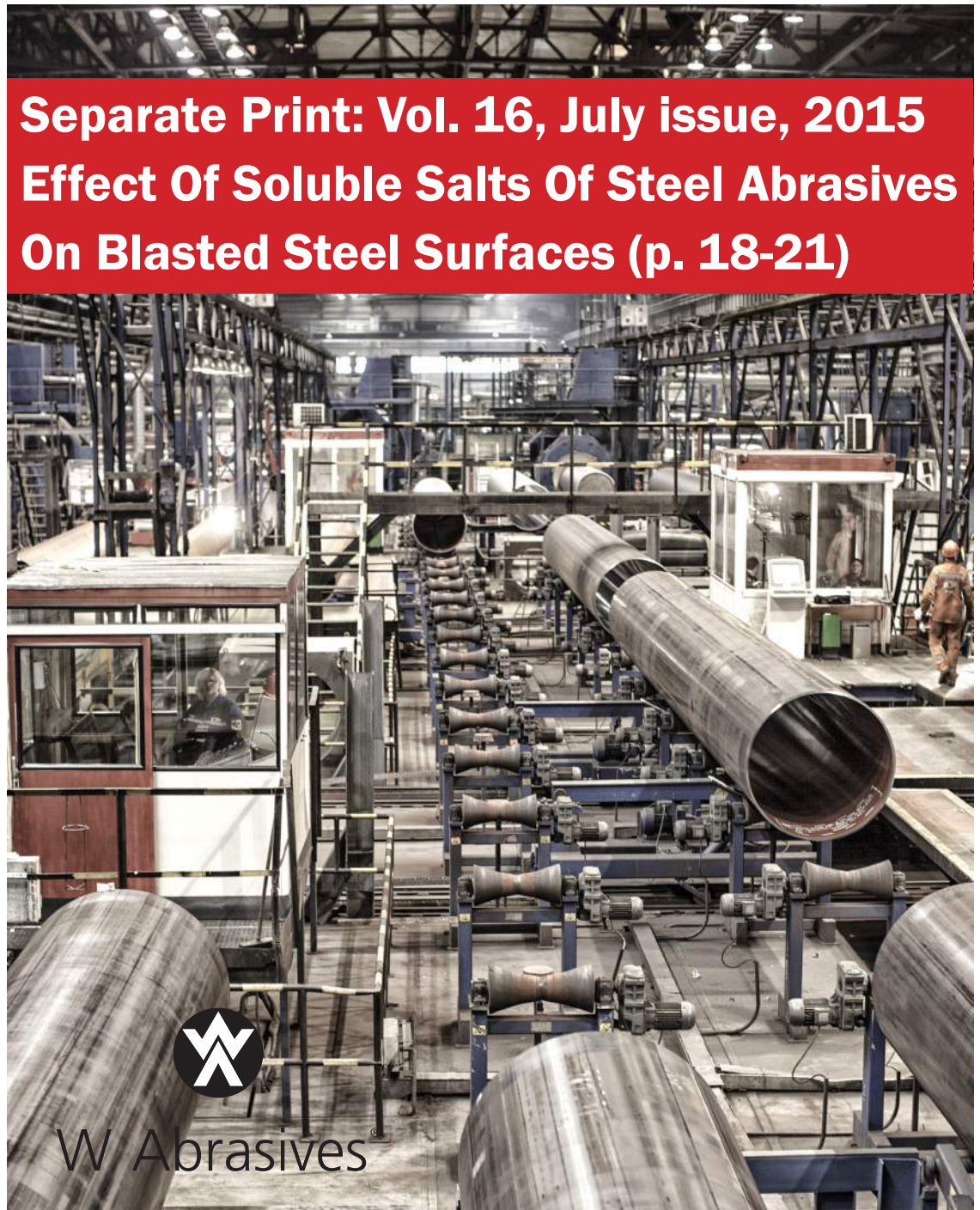
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On Blasted Steel Surfaces (p. 18-21)**



W Abrasives

Effect Of Soluble Salts Of Steel Abrasives On Blasted Steel Surfaces

Abstract: Two steel abrasives of similar characteristics but different levels of soluble salts were used to blast a clean steel plate. One abrasive was representative of W Abrasives, with low salts presence. The other, representative of a competitor, had a high level.

Results evidence that the soluble salts in the competitor's abrasive were transferred to the blasted surface up to levels above the standards of the pipe coating industry, risking the quality of the surface prior to coating in other applications.

Keywords: steel abrasives, blasting, soluble salts, conductivity, corrosion, coating.

1. Introduction

Among the various variables under scrutiny in surface preparation industry, the presence of soluble salts over steel surfaces is attributed as a major cause of premature coating failure, with claims from forensic failure inspections running over 60% [1].

There have been studies performed to correlate the level of soluble salts of steel surfaces and the coating perfor-

mance, which are permitted to define various specifications and guidance levels depending on coating systems and operating environments. However, limited studies have been performed to know the extent to which soluble salts present in steel abrasives may contaminate the surface during an abrasive blast.

WINOA, as the worldwide leader in manufacturing of steel abrasives, sold under W Abrasives brand, wants to con-

tribute to the sector with such a study as what it is being presented in this article.

2. Understanding soluble salts

The environment is filled with sources of salt contaminants, both natural and man-made. Virtually every surface is subject to salt contamination at some level.

Soluble salts are described in the Society for Protective Coatings (SSPC) as "An ionic chemical compound that dissolves in water to form a solution of positive and negative ions." The prime detrimental salts most commonly encountered are chloride, sulfate and nitrate, though specific industries may encounter others.

Salts have various effects over a steel surface, one of them being that salts draw moisture from the environment. As all polymers are permeable to water to some extent, there will be an increase of the osmotic pressure in the interface steel-coating, leading to blistering and disbondment of the coating (see Figure 1).

There are several field methods to test and to determine the contamination levels. One method to extract contaminants from the steel surface is the Bresle method, which is described in the standard ISO 8502-6 [2]. This method consists of sticking a patch on the steel surface, putting distilled water in contact with the steel by means of a syringe, and dissolving the contaminating salts. For the subsequent analysis of contaminants, ISO 8502-9 [3] can be employed in order to determine the total surface density of salts.

It has been determined that any amount of salt is detrimental to the overall lifespan of the coating. The cleaner the surface, the more successful the coating. It is difficult to set acceptable levels since each type of coating and thickness varies in susceptibility to soluble salt degradation. It is generally agreed that a level below 30 mg/m² of soluble salts is highly desirable [4].

In ISO/TR 15235:2001 [5], there is a compilation of different limits and guidance



Example of detrimental effect of soluble salts (surface corrosion)

Blasting

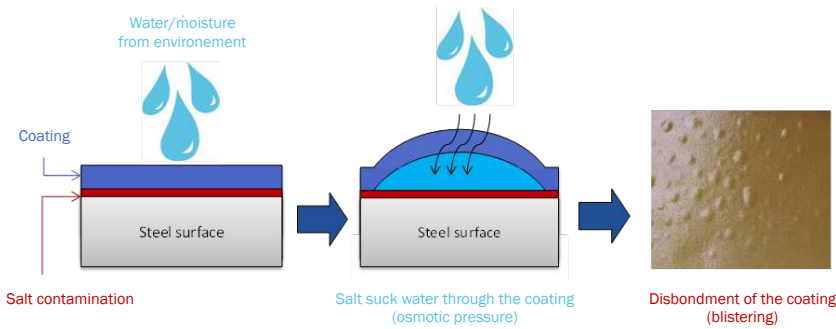


Figure 1: Representation of blistering effect

Conductivity values are given in $\mu\text{S}/\text{cm}$, which is equal to $\mu\text{mho}/\text{cm}$. Maximum permitted value in International Standards is set at $1000 \mu\text{S}/\text{cm}$, as per SSPC-AB-3 Standard [8]. However, for the ASTM D4940 Standard, "a typical value of conductivity for a high level of contamination is $500 \mu\text{S}/\text{cm}$. A typical value for a low level of contamination is $50 \mu\text{S}/\text{cm}$."

It must be noted that, if performed adequately, heat treatment processes such as air quenching can reduce the levels of soluble salts. This is a potential advantage of high carbon abrasives (Carbon content around 1%) versus low carbon

levels, but since it is a Technical Report and not a Standard, they can just be taken as guidance.

method, compared to the conductivity test with Bresle, does not identify the ionic species.

Considering the Standard ISO 21809-1:2011 [6], applicable to the petroleum and natural gas industries (pipe coating), the maximum allowable level shall be $20 \text{ mg}/\text{m}^2$ after blasting as per ISO 8502-6 and ISO 8502-9.

	Atomized (as cast)	Austenized and water quenched	Austenized and air quenched
Conductivity ($\mu\text{S}/\text{cm}$)	49	106	11

Table 1: Example of variation in conductivity of high carbon steel shot. Conductivity range of atomizing and quenching water used: $300\text{-}600 \mu\text{S}/\text{cm}$.

Soluble salts on steel abrasives

Soluble salts can be present on abrasives. Depending on their concentration, even an abrasive blasting performed adequately could leave behind the beginnings of corrosion.

In this article, the focus is on steel abrasives, which are the abrasives manufactured by WINOA Group under the brand W Abrasives.

The critical salt transfer processes during steel abrasive manufacturing are those in which there is water contact (atomization and, eventually, water quenching), depending on water quality. The environmental conditions within the plant can further increase soluble salt concentration. The isolation provided by the packaging and storing conditions also needs to be considered.

The measurement of soluble salts is performed indirectly through conductivity testing, following the ASTM D4940 method [7]: abrasive and pure water are combined into a slurry that is stirred to leach the soluble salts (chlorides, sulfates, nitrates...) from the abrasive. This slurry is filtered and conductivity of the filtrate is measured. This test



Large diameter steel pipes heading to the external blasting machine

(Carbon content around 0.1%), which are normally sold as cast.

3. Purpose of the study and methodology

The purpose of the study is to check the degree to which conductivity of abrasives is transferred to the surface blasted, and compare the results with requirements of surface preparation industry.

For this purpose, a W Abrasives sample and sample from a competitor were used to air blast a clean steel plate under the following conditions:

- 5,5 bars of pressure
- 10 mm Venturi nozzle
- 70° incidence angle
- Cleanliness after blasting: Sa 2 ½, as per ISO 8501-1 [9]

Afterwards, an Elcometer 138 Bresle salt kit was used in order to determine the level of soluble contaminants, following ISO 8502-6 and ISO 8502-9.

Conditions of analysis:

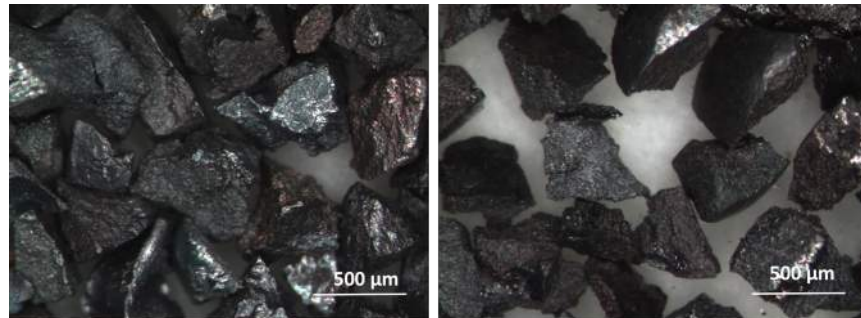
- Solvent used: distilled water
- Volume of solvent injected: 3 ml
- Total contact time: 10 minutes
- Temperature: 25 °C
- Patch size A-1250, compartment area 1250 mm² ± 13
- Patch batch number: 02563
- Conductivity measurement range: 0 μS/cm to 199 μS/cm
- Date: 12/03/2015

In order to convert conductivity to surface density of soluble contaminants, the following formula, obtained from ISO/TR 15235:2001, was used:

$$\text{mg/m}^2 = \mu\text{S/cm} * 1,18$$

	W Abrasives	Competitor
Conductivity (ASTM D4940, μS/cm)	17	627

Table 2: Conductivity of abrasives



W Abrasives grit (left) and competitor grit (right)

Finally, a detailed analysis of the surface roughness and visual checks were performed to ensure that the soluble contaminants were obtained under similar surface conditions.

4. Results

Steel abrasives

The chemical composition, hardness, size and microstructure showed no relevant differences between both abrasives. The main difference found was in the level of salt contamination, as seen in Table 2.

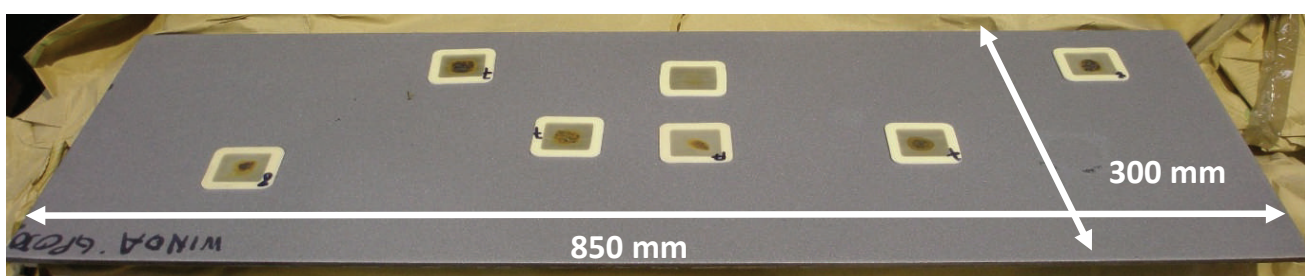
Steel plate

Regarding surface profile, the resulting roughness values were similar between both abrasives (Rz in the range of 80 to 90 μm, and Pc in the range of 70 to 80 peaks/cm), which indicates that the adhesion strength of the future coating would be similar for both surfaces, provided that the cleanliness level was Sa 2 ½ on both cases.

Regarding surface contamination with soluble salts, Table 3 shows the levels of soluble contaminants in mg/m².

Bresle Test Method: ISO 8502-6/9	Test number	Steel plate before blasting	Steel plate after blasting with W Abrasives	Steel plate after blasting with competitor product
	1	11	10	30
	2	12	8	28
	3	10	10	28
	4	11	8	23
	5	10	8	26
	Average	11	9	27

Table 3: Surface density of soluble contaminants in mg/m² (Bresle, ISO 8502-6/9)



Steel plate. Different areas were tested with the Bresle method.

Blasting

As can be seen, there has been a transfer of soluble salts from the competitor's abrasive to the steel plate, leading to an average value of $27 \text{ mg/m}^2 > 20 \text{ mg/m}^2$, therefore out of specifications for pipe coating considering the ISO 21809 Standard.

The areas blasted with W Abrasives shows lower levels of soluble contaminants than the initial steel plate, in spite of testing over a bigger surface (one effect of blasting is the increase of total area due to the peak/valley profile created)

5. Conclusions

The presence of soluble salts in steel abrasives, tested through conductivity measurement, can contaminate the blasted surface up to levels that would be a cause of rejection in some applications such as the pipe-coating industry.

As opposed to other abrasives found on the market, W Abrasives products, due

to their state-of-the-art manufacturing processes, exhibit minimum presence of soluble salts, ensuring a perfect surface preparation with no risk of premature coating failure.

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