Chapter 3

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PRE-TREATMENT OF THE SURFACE AND ITS INFLUENCE ON THE COATING QUALITY

Abstract: The aim of this paper is the evaluation of the surface pre-treatment influence on the final quality of the powder coating by the steel rolled sheet metal. The introduction is devoted to the surface pre-treatments – to the kinds of pre-treatments and the most common problems which can occur during the pre-treatment process. The experimental part is devoted to the evaluation of the surface pre-treatment on the powder coated sheets quality after the salt spray corrosion load in the corrosion chamber. The nanotechnology based product for the chemical pre-treatment of the steel materials commonly used in the practice (constructions, automotive industry and so on) is evaluated in this paper. This product is compared with classical phosphate surface pre-treatment. The samples were put in to the corrosion chamber and after that they were evaluated from the macroscopic point of view; we evaluated the degree of blistering, degree of delamination and corrosion. Based on the results from experiment were pronounced conclusions and recommendations from the point of view of the surface pre-treatment by the steel metal sheets and the influence on the final coating quality.

Key words: surface pre-treatment, powder coating, corrosion resistance, final coating quality, macroscopic analysis

3.1. Introduction

The surface pre-treatment is one of the most important elements in the product or construction service life. The surface pre-treatment we

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have to choose in such a way to achieve the optimal service life with the optimal (the lowest) costs. The pre-treatment process has not only the technological part. Process has the control and organizational part too. All these parts of the technological process have performed the low costs and the required final surface quality.

The surface cleanliness has big influence on the service life and the final quality of the surface treatment. The insufficient quality and improperly chosen surface pre-treatment can in result devalue the material and cause significant damage for example in the form of corrosion (KUDLACEK, KREIBICH 2008).

When we design the surface treatment technology it is needed to choose technology most suitable for that purpose. The suitability is choosing for example accordingly if it has fulfilled technical or the esthetic function too and by the amount of costs. The important factor is ecological aspect (sewage sludge, toxic waste, hazardous substances emitted to air, waste alkalis and acids etc.) at present (MICHNA, NOVÁ 2008).

The surface pre-treatment are:

- mechanical – grinding, brushing, polishing, blasting, tumbling,
- chemical and electrochemical – alkaline degreasing, rust removal, pickling, chemical polishing.

The conversion coating can be used after the mechanical and chemical pre-treatment to increase the adhesive force between the base material and final coating. This conversion layers are nonmetallic inorganic layers which we can be divided:

- passivation (chromate),
- phosphate (iron, zinc, etc.),
- oxidation (blackening steel etc.).

Except the better adhesion this processes increase corrosion resistance (KREIBICH 1991). The conversion coatings create deliberate exclusion of oxides, phosphates or chromates on the material surface. The mechanism of their formation is based on the conversion of its own metal surface to chemical compounds which are firmly anchored to the surface and give it the desired properties (GEIPLOVÁ, BENEŠOVÁ, PARÁKOVÁ 2012).

Mechanical and chemical pre-treatments are used to the removing impurities from the surface of the material, creating of the suitable anchor profile of the surface and suitable clean surface for applying the final coating.

Before creating of the final coating the material surface must be clean and free of corrosion products. Inconsistency in the implementation of surface preparation is usually reflected immediately after final finishing, but only after a certain time, after which the impurities are developing and they need to breach the integrity and adhesion of the final surface layer (MICHNA 2008).

3.2. Experiment

The experimental base material was chosen Fe Hestego. It is the commonly used steel sheet metal (unalloyed, low carbon). The treatment of the base material is shown in Table 3.1.

Table 3.1. Experimental samples treatment

Basic material	Fe Hestego	Unalloyed steel	Low carbon steel
Mechanical pre-treatment	Soft blasting (the same for all samples)	Average roughness Ra 1,95 μm	-
Chemical pre-treatment	**D** – CC + Zr	**E** – Feph + Zr	**F** – CC + Feph + Zr
Final coating	Powder coating (the same for all samples)	TIGER Drylac	Thickness 60 – 80 μm
Note: CC – alkaline degreasing, Feph – iron phosphating, Zr – nanopassivatino, applied by dipping			

Salt spray corrosion test was performed according to the standard EN ISO 9227. The corrosion load time in salt spray chamber is – 1 000 hours. The amount of the samples was chosen: 4 samples in each group **D** – D3-1, D3-2, D3-3, D3-4; **E** - E3-1, E3-2, E3-3, E3-4, **F** - F3-1, F3-2, F3-3, F3-4. The cross scribe was performed on the surface of all samples (except the D3-4, E3-4, F3-4 where we examined the blistering on the sample surface according to the standard ČSN EN ISO 4628-2). We analyzed the degree of delamination and corrosion according to the standard ČSN EN ISO 4628-8.

The experimental samples with the scribe from the group D are showed on the Figure 3.1.

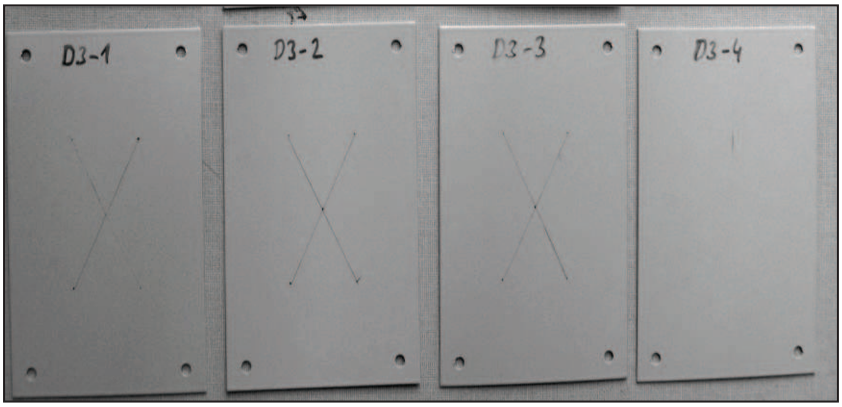

Fig. 3.1. The experimental samples – group D.

Source: own study

3.3. Results of the experiment

We performed the analysis of the experimental samples pre-treated according to the Table 3.1 after 1 000 hours in salt spray corrosion chamber.

The evaluation of the samples group D

Table 3.2. Evaluation of the samples with the pretreatment D

The sample	**D3-1**	**D3-2**	**D3-3**	**D3-4**
Blisters on the surface	0(S0)	0(S0)	0(S0)	2(S4)
Blisters on the scribe / **Size (length)**	S0(0)	S5(0-2mm)	S0(0)	-
Corrosion in the scribe	Degree 3 – mild	Degree 5 – very large	Degree 4 - significant	-
Delamination	Degree 5 – very large	Degree 5 – very large	Degree 5 – very large	-

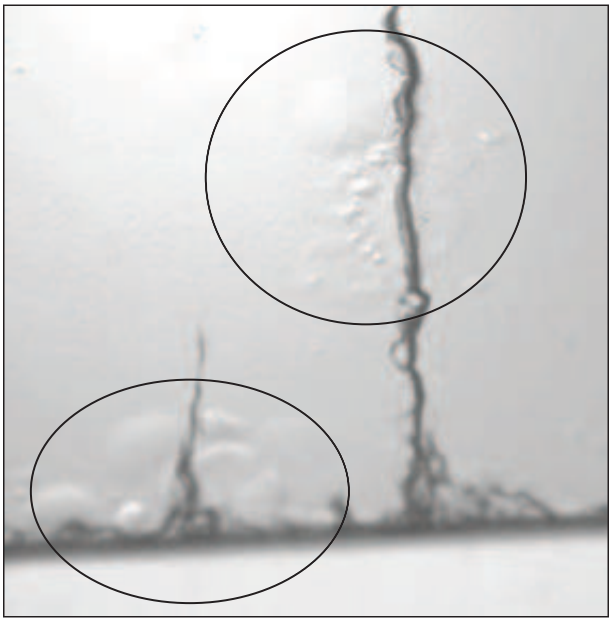

Fig. 3.2. The blistering on the sample surface D3-4.

The evaluation of the samples group E

Table 3.3. Evaluation of the samples with the pretreatment E

The sample	**E3-1**	**E3-2**	**E3-3**	**E3-4**
Blisters on the surface	0(S0)	0(S0)	0(S0)	0(S0)
Blisters on the scribe	S0(0)	S5(0-2mm)	S0(0)	-
Size (length)				
Corrosion in the scribe	Degree 4 - significant	Degree 5 – very large	Degree 5 – very large	-
Delamination	Degree 5 – very large	Degree 5 – very large	Degree 5 – very large	-

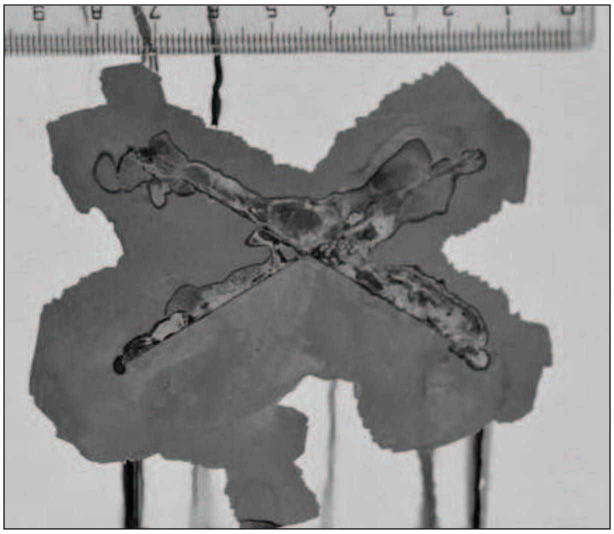

Fig. 3.3. The delamination on the sample surface E3-3.

The evaluation of the samples group F

Table 3.4. Evaluation of the samples with the pretreatment F

The sample	**F3-1**	**F3-2**	**F3-3**	**F3-4**
Blisters on the surface	3(S4)	0(S0)	0(S0)	0(S0)
Blisters on the scribe Size (length)	S4(0-10mm)	S0(0)	S0(0)	-
Corrosion in the scribe	Degree 5 – very large	Degree 3 – mild	Degree 3 – mild	-
Delamination	Degree 5 – very large	Degree 4 - significant	Degree 4 - significant	-

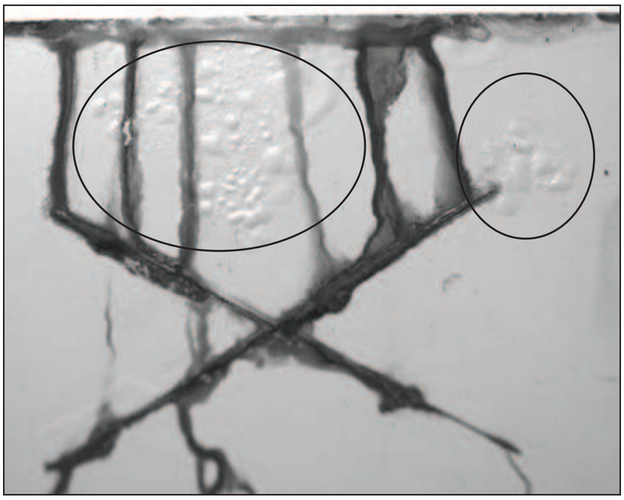

Fig. 3.4. The blisters on the surface and on the scribe F3-1.

The degree of delamination and corrosion was evaluated according to the picture standards listed in the standard ČSN EN ISO 4628-8 Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 8: Assessment of degree of delamination and corrosion around a scribe. There is documented the sample D3-4 at the picture X.2. We can see blistering at the edge of the sample and in the middle of the sample. The sample E3-3 is at the picture X.3. We can see extensive delamination and corrosion around the scribe. There are the blisters at the edge of the samples in this group E. The sample F3-1 is documented at the picture X.4. We can see the blisters on the surface of this sample and at the edge too. We performed the delamination analysis and after that it occurred to the very large delamination and to the completely peeling of the coating from the sample to the edge.

3.4. Summary

The Insufficient or wrong surface pretreatment leads in most cases to the formation of blistering reduced adhesion powder coatings and corrosion under this coating. The aim of this paper is the evaluation of the surface pre-treatment influence on the final quality of the powder coating by the steel rolled sheet metal.

In conclusion we can state the influence of surface preparation. The best results (delamination and corrosion) achieve the samples from the group F, which used a combination of surface pre-treatment (CC+Feph+Zr). The worst results have the sample group E series without alkaline degreasing. We can therefore conclude that the alkaline degreasing in the surface preparation is suitable pre-treatment. All samples have blistering around the edges of the samples. The edges are the weak point of all products and structures.

In protecting material finishes should be taken not only to quality surface preparation but also the compliance procedure for the application of coatings by the manufacturer's recommendations and standards.

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