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Macroscopic quality evaluation of lacquered steel sheets

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Abstract This paper deal with the evaluation of quality of lacquered sheets with different pre-treatments after corrosive loading. Samples will be divided into groups according to the type and duration corrosion loadings. After exposure to corrosive salt mist corrosion chamber, the samples will be evaluated macroscopically according to relevant standards. Low degradation after all time corrosion load was on the sample pre-treated with an alkaline degreasing in combination with a yellow chromating and the samples pre-treated with an alkaline degreasing in combination with surface passivation. On these samples showed no loss of adhesion to the base material and the evaluation of delamination due to corrosion during loading had a low degree of degradation. Surfaces after the cross-cut test did not for both sets of samples after corrosion load all times no defects in the adhesion layer.

Key words – macroscopic evaluation, quality, lacquered sheets, pre-treatment

1. Introduction

The issue of corrosion and corrosion protection of metals belong to the field of applied research and development. This field draws on knowledge from many disciplines, such as physics, chemistry, metallurgy, polymer chemistry, inorganic chemistry, etc. The theme of protection against corrosion affects virtually all industrial and non-industrial sectors (BARTONÍČEK, 1986). Part of this problem is the search for solutions in the pre-treatment of the basic material before applying the lacquer layers so that the whole technological process was removed by pretreatment of the base phosphate.

The most common surface protection components include creating protective coatings from a wide range of inorganic and organic substances (paints, plastics, etc.). Before application of these compounds is important the right choice and design of pretreatment surfaces (KREIBICH, 1996, KRAUS, V. 2000).

Pretreatment can be divided into two basic types, namely mechanical and chemical. The chemical pretreatment include degreasing in organic solvents and phosphate. It is a widespread method, but the legislation of the European Union is under pressure to reduce the use of hexavalent chromium, reduce heavy metals and improve the quality of wastewater discharged.

That is why the search for new pre-treatment of surfaces, which is trying to replace these adverse effects on the environment. The modern technology is often used surface passivation technology, alkaline degreasing. In comparison with the ferric phosphate has a much greater ability to degreasing, longer life, it can be used for a wide range of metals and operates at room temperature, therefore no costs for heating bath. The latest technology types include E-CLPS (PALKO, 2009). The basis of these products are highly reactive silanes, which form when it reacts with the surface material of a chemical bond. Silanes are highly networked inorganic layer on the surface of the material with a thickness of 50-100 nm, and thus creates a barrier effect, thereby increasing the corrosion resistance of the material, particularly in combination with the subsequent powder coating system. Another option is to cataphoresis painting - among the most advanced coating technology, and especially meets the requirements of economical and ecological operation (HOLOUBEK V. 2005, BORKOWSKI S., KNOP K. 2013.).

The aim of this paper is to make macroscopic evaluation of the quality of painted plates with various means of pretreatment according to CSN EN ISO. Attention will be focused on modern methods of pre-treatment, respecting the requirements of current trends in ecology.

2. The metodology of the experiment, experimental samples

By macroscopic evaluation of the quality of painted metal sheets after corrosion load there are several options on how to proceed. The article will be presented using processes and methods in accordance with the standards ISO: CSN EN ISO 4628, CSN EN ISO 2409 Paints and varnishes - Cross-cut test, CSN EN ISO 4628-8 Paints and varnishes - Evaluation of degradation of coatings.

As an experimental sample material was used Q-panel Fe, used for experimental testing of protective coatings from surfaces. The material has the chemical composition given in Table 1. A set of samples was divided into groups I - VI according to the type of pretreatment, Table 2.

Paint Tiger Drylac Serie 29 - powder coating based on polyester designed for metal facades and steel constructions. The thickness of the applied layer is at least 60 to 80 micron and should not exceed more than 110 microns. By the curing process it is necessary to avoid exceeding the object temperature over 200°C.

All samples were used for the drying temperature from 90 to 100 ° C/10 min type coating TIGER Drylac ® Series 29, firing temperature and time of 180 °C/20 min. Thus prepared samples were divided into three main groups according to the load of corrosion. Corrosion load was empirically chosen on 480, 720 and 1000h for all sets of samples. For corrosion experiment was used diagnostic tool LIEBISCH ® test chamber, working conditions by standard CSN EN ISO 9227.

Table 1. Chemical composition of Q-panel Fe

Material	C %	Mn %	P %	S %
Q-panel Fe	0.12	0.60	0.045	0.045

Table 2. Distribution of simplex according to the different types of pretreatments

Group	Pretreatment
I	CC + ZircaSil 18 + KTL
II	Ferroclean + Alfipas 725
III	Ferroclean + Zircasil
IV	Ferroclean + E-CLPS 1900
V	Ferrophos 7767/2
VI	Sandblasted + Ferrophos

3. Macroscopic evaluation of the quality lacquered layers with different pre-treatment

Sets of samples were successively selected from corrosive environment. Individual samples were macroscopically evaluated according to these standards.

- **Corrosion load 480 h**

Evaluation of delamination: Evaluation of the delamination degree according to CSN EN ISO 4628-8 after 480h showed that most samples reached by picture standard grade 5 and the highest degree of delamination, Tab. 8.3 according to macroscopic images is clear that the most corrosion damage occurred in a set of samples VI-VI. On these samples are peeling off a large part of the protective layer that completely lost adhesion to the base material. Technology E-CLPS probably wrong adhered to the basic material or the coated layer wrong adhered to the layer of silane.

The lowest corrosion attack was from a set of sample I and III. Both samples were classified as grade 1 - very small delamination. The results suggest that an important aspect of good pretreatment removal of impurities from the surface before applying additional layers. This ensures alkaline degreasing, which was used for all samples with a good result evaluation delamination.

Cross-cut text: Based on the evaluation of cross-cut test according to standards were found defects in the protective layer adhesion to the base material. Samples were classified as grade 0 - no damage.

- **Corrosion load 720 h**

Evaluation of delamination: the greatest damage occurred in samples sets IV to VI, which was disrupted by adhesion to the base material and was under corrode most of painted layers. This led to large parts of the peeling of surface layer. About 2 degrees, compared with load 480h, increased degree delamination of the sample from a set III.

Cross-cut test: for corrosion load 720 hours there were changes in the behavior of the protective surface because defects were found in the protective layer adhesion to the base material.

The greatest damage was classified by degree 5 for a sample from a set of IV with alkaline degreasing pretreatment and technology E-CLPS. It was found significant disruption of adhesion, both in assessing delamination and subsequently in the cross-cut test. Grade 2 was evaluated from a set of sample I with alkaline degreasing pretreatment, surface passivation and KTL. On this sample was observed beginning of corrosion on peeling of locations after the cross-cut test. Other samples were classified as grade 0 - no damage.

Summary of the results of classification tests after corrosion load 720h has been found that the worst case of the protective layer had sample from the set IV, ie with alkaline degreasing pretreatment and E-CLPS technology. Results of the evaluation of delamination and cross-cut test show a loss of adhesion to the base material.

- **Corrosion load 1000 h**

Evaluation of delamination: From the macroscopic images is evident that the greatest damage occurred in samples IV to VI (Fig. 1) which confirmed the previous trend surface behavior in response to a corrosive environment. By the samples were severely disrupted adhesion of the protective layer and was peeling off the protective layer of almost the entire surface of the sample.

For a sample of group III nor increasing the duration of the corrosive effect of 720 h at 1000 h did not cause changes in the final stage of the assessment, which remained the same at 3 degree of delamination.

About 1 degree worsened condition of the surface of the sample set II. Three classification grades worse outcome compared to corrosion load 720h was evaluated sample sets I, which showed loss of adhesion due to corrosion under the protective layer.

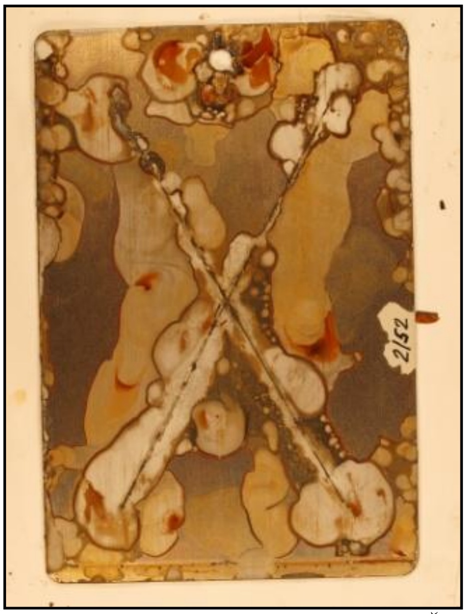

Fig. 1 Evaluation of delamination according to ČSN EN ISO 4628-8 – 1000h, IV - Ferroclean+E-CLPS, Degree: 5 – very large

Cross-cut test: according to cross-cut test CSN EN ISO defects were found in the protective layer adhesion to the base material, which are shown in Fig. 2.

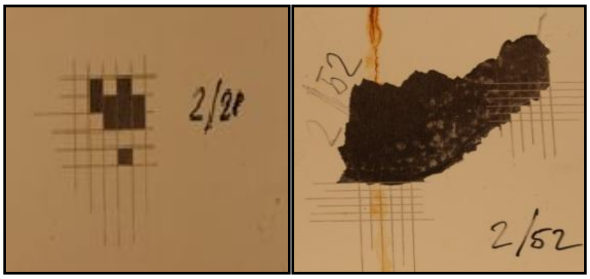

Fig. 2 Cross-cut test, corrosion load 1000h, left: sample set I, right: sample set IV.

At the sample set IV was classified stage degradation 3. The sample group IV was classified at grade 4 in the cross-cut test place test, but in the vicinity cuts is peeling off a large part of the protective layer, which lost adhesion of to the base material. Grade 2 was evaluated sample pretreatment group I alkaline degreasing, surface passivation and KTL. Other samples were classified as degree 0 - no damage.

The highest corrosion load time 1000h resulted in noticeable signs of corrosion damage even some samples that still resist corrosion load well.

4. Conclusions

Most corrosion attacked were specimens with alkaline degreasing pretreatment, in combination with E-CLPS technology. Already after 480 hours of corrosion load by the evaluation of delamination there was seen the peeling off a large part of the protective layer. Cross-cut test this loss of adhesion to the base material confirmed. After 1000 hours of load corrosion has occurred on the upper part of the specimen to almost complete loss of adhesion and the protective layer is separated from most of the base material. Even though it is a modern organic method, it certainly is not for this type of material and coatings recommended.

Samples pretreated by alkaline degreasing, surface passivation and KTL technology are ranked after corrosion 480h load between samples with a low degree degradation of the protective layer. After further corrosion load has been a loss of adhesion to the base material which show cross-cut test. On the peeled of sites was apparent corrosion under protective layer.

Low degradation after all time corrosion load was on the sample pre-treated with an alkaline degreasing in combination with a yellow chromating and the samples pre-treated with an alkaline degreasing in combination with surface passivation. On these samples showed no loss of adhesion to the base material and the evaluation of delamination due to corrosion during loading had a low degree of degradation. Surfaces after the cross-cut test did not for both sets of samples after corrosion load all times no defects in the adhesion layer.

Based on macroscopic evaluation of degradation of painted plates with different pre-treatment i.e. for a specific type of paint and basic materials can be recommended pretreatment with surface passivation, which has made good progress and is not used against chromate at his process hardly degradable substances.

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