

EVALUATION OF SHEET DEGRADATION WITH SURFACE TREATMENT

Sylvia Kusmierczak, Natasa Naprstkova, Jaroslava Svobodova
Jane Evangelista Purkyně University in Ústí nad Labem, Czech Republic
kusmierczak@fvtn.ujep.cz

Abstract. The article focuses on analyzing the behavior of surface-treated sheets, which were exposed to the corrosive effects at different times. After the samples corrosion load the state of the surface layers was analyzed and then a microscopic analysis of the protective coatings was made. The sheets differed by pre-treatment, as well as the actual type of the protective layer. Based on the results of the analysis the optimal combination of pre-treatment and surface modification of the basic material was recommended.

Keywords: surface, degradation, sheet.

Quality of processed surface for various purposes is also important

Corrosion of metals and alloys is a spontaneous and irreversible process of disintegration of metallic materials due to their chemical or electrochemical reaction with the surrounding aggressive environment, leading to a loss of functional properties of products made from these materials [1 – 3]. The most common ways to protect metal products are: the choice of suitable material modification of the environment, changing the construction design, production technology, application of electrochemical protection and finishes. Among finishes a certain position is held by coats of paint, which are the most common technology in the total volume of surface treatments. It is possible to perform the rating degradation of painting by a number of standard-based procedures. [1; 4 – 6] It is possible to complement by the macro-and microscopic evaluation of the state of the coatings.

Experimental materials and testing conditions

As an experimental material Q-panel Fe – a material made for laboratory purposes was used, it is non-alloyed steel intended for deep drawing. The top of the protective layer for the sample S/1 was polyester 7035, for the sample S/2 and S/3 polyester RAC 5013, for the sample S/4 the SILVER METALIC + clearcoat.

The samples were on the surface received by a full phosphating, alkaline degreasing and passivation [2]. The samples were exposed to corrosive load according to EN ISO 9227 at 240, 480 and 720 hours. For the experiment a diagnostic corrosion device Liebisch ® was used (Fig. 1).



Fig. 1. Corrosion chamber

Macroscopic evaluation

Macroscopic evaluation describes the behavior of the samples after exposure to corrosive load. Table 1 presents the sample after corrosion load.

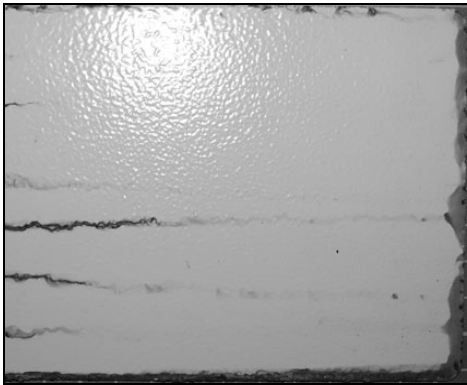
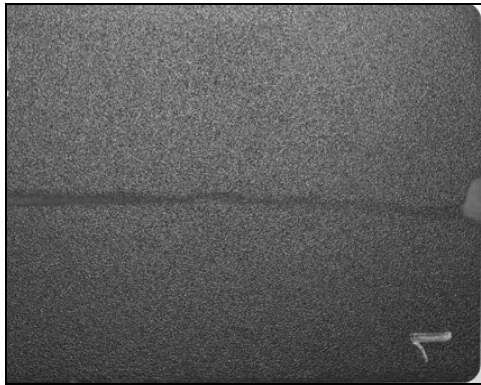


The visual evaluation of samples after corrosion effects includes the evaluation of degradation of coatings according to ČSN EN ISO, too. All samples were tested under the same conditions and by

using the same evaluation methods. Therefore, as a representative example the sample S/3 was selected.

The evaluation was performed according to ČSN EN ISO 4628-2 Assessment of the degree of blistering, ISO 4628-3 Assessment of the degree of rusting, EN ISO 2409 Paints - Cross-cut test. As an example there are reported the scores of the sample S/3 (Fig. 2).

Table 1

Samples after corrosion load

S/1	S/2
	
S/3	S/4
	

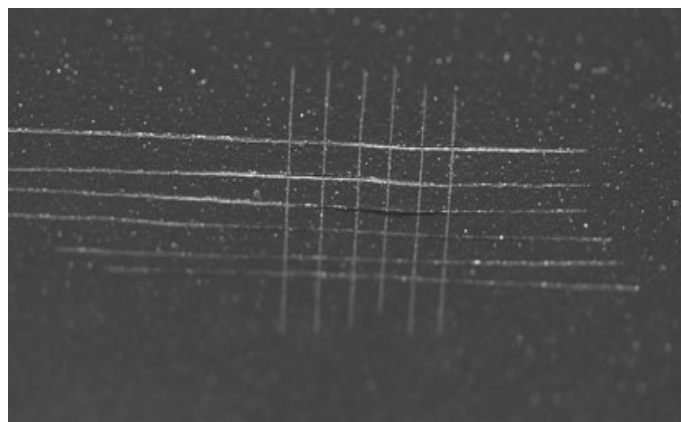


Fig. 2. S/3, Cross-cut test

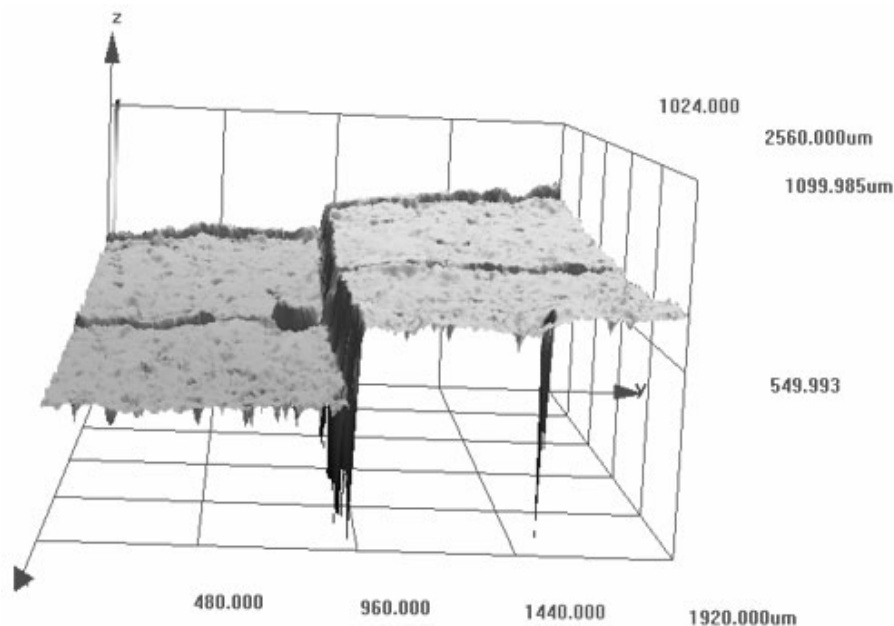


Fig. 3. S/3, sample corrosion, delamination

This sample shows after a cross-cut test also damaged paint finish. There was peeling off paint. The paint did not snap to the base material and produced a coherent surface coating with no ties to the basic material. In Figure 3 there is a visible ripple of the surface coating and paint damage on the cross-cut test. The sample S/3 was classified as grade 5. Corrosion under the paint in the place of the cross-cut test did not come out. For this sample a confocal microscope was used and a 3D model was made, which highlighted a paint not connecting with the basic materials, Figure 3. The results of the macroscopic analysis for all samples are listed in Table 2.

Table 2

Evaluation of visual and macroscopic examination

Sample		S/1	S/2	S/3	S/4
Material	Q-panel Fe	•	•	•	•
Surface pretreatment	Alkaline degreasing	•	•	•	•
	Passivation	•	•	•	–
	Nongrinding	•	•	•	•
Surface coating	Polyester/7035	•	–	–	–
	Polyester/RAL 5013	–	•	•	–
	Silver metallic + clearcoat	–	–	–	•
Corrosion load time	480 hours	•	•	–	•
	720 hours	–	–	•	–
Blistering	degree 1 – 4	*	*	*	*
Rusting	degree 1 – 5	*	*	*	*
Delamination	% surface affection	*	1	90	*
Corrosion	Attack rates in the surface, mm	*	*	8	*
Cross-cut test	Degree 0 – 5	0	4	5	0

* No defect

• With defect

Microscopic evaluation

Microscopic observation was performed on a confocal laser microscope Olympus LEXT OLS 3100. It was aimed at assessing the state of the degraded protective coatings.

The sample S/3 is documented in Figure 4 and 5.

In this sample the edge coating was not stripped away. Peeling is evident only at a distance of approximately 40 μm from the edge of the sample. This peeling off could be caused by imperfect surface preparation. The bottom layer of the coating is uniform and is adjacent to the base material. The top layer of the coating is rugged. The pore is located on the coating with the size of about 60 μm . Distribution of pores in the coating is irregular.

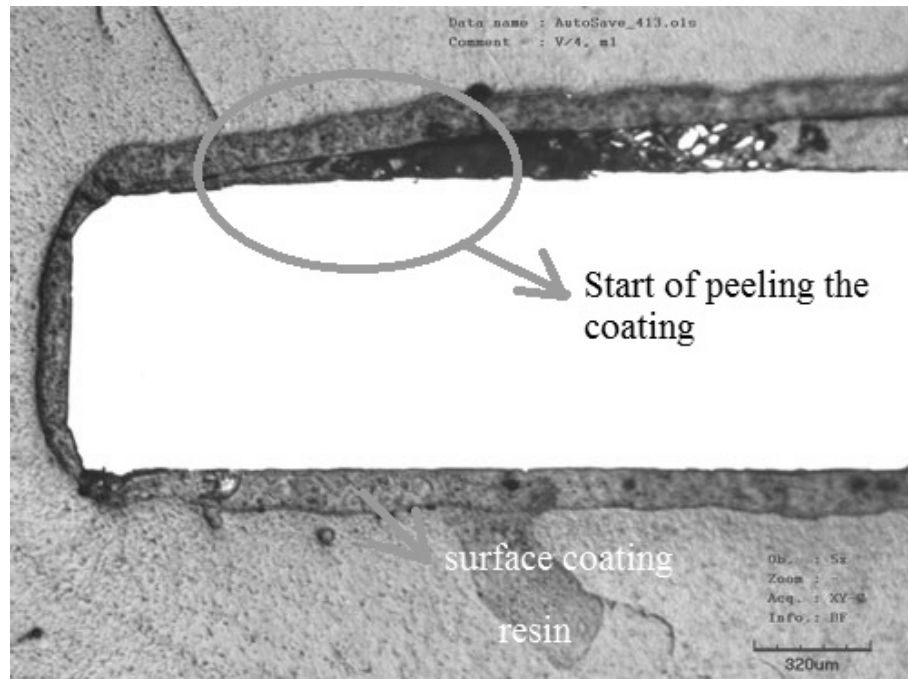


Fig. 4. V/4, state of the corrosion protective layer load

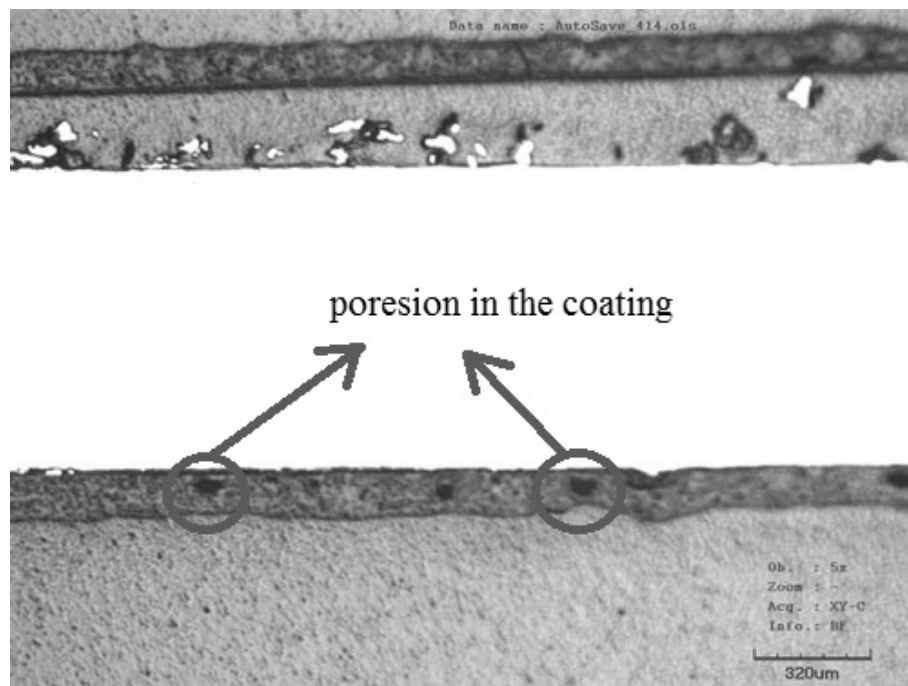


Fig. 5. V/4, defects in the surface coating

Conclusions

Resistance of the coating is, of course, dependent on the time of the corrosion load. The results of the macroscopic evaluation show that phosphate may be replaced by an alkaline degreasing because the phosphate pretreated samples have similar results as the samples pretreated with alkaline

degreasing. The results of the microscopic analysis also indicate the possibility of withdrawal of phosphating. Phosphating can be replaced with alkaline degreasing followed by passivation. The microscopic analysis revealed frequent defects in the protective surface layers in the form of bubbles and pores. The occurrence of these defects is probably related to imperfect surface finish before applying the protective layer. To correct the defects in the protective coating and the subsequent degradation of the coating it is necessary to ensure observance of technological discipline.

Acknowledgements

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References

1. Michna, Š., Nová, I. Technologie a zpracování kovových materiálů, Adin, 2008, ISBN 978-80-89244-38-6.
2. Müller, M., Valášek, P Adhesive bonds degradation. In 9th International scientific conference engineering for rural development. Jelgava: LUA, 2010, p. 49 – 52. ISSN 1691-3043.
3. Müller, M., Valášek, P. Interaction of steel surface treatment by means of abrasive cloth and adhesive bond strength, Manufacturing technology, 2010, vol. 10, pp. 49 – 57.
4. ČSN EN ISO 4628 – 2. Nátěrové hmoty – Hodnocení degradace nátěrů, Část 2: Hodnocení stupně puchýřkování 673071, (april 2004, ICS 87.040.
5. ČSN EN ISO 4628 – 3. Nátěrové hmoty – Hodnocení degradace nátěrů, Část 3: Hodnocení stupně prorezavění 673071, duben 2004, ICS 87.040.
6. ČSN EN ISO 2409. Nátěrové hmoty – Mřížková zkouška 67 3085, říjen 2007, ICS 87.040.
7. ČSN EN ISO 4628 – 8. Nátěrové hmoty – Hodnocení degradace nátěrů, Část 8: Hodnocení stupně delaminace a koroze v okolí řezu 67 3071, listopad 2005, ICS 87.040.