

## DEGRADATION OF COATINGS IN CAR REPAIR

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**Abstract.** In the automotive industry, respectively in car repairs, we often meet with the need to repair the car body. During the repairs it often extends to the original grinding Zn layer base material – sheet. The paper aims to analyze the degradation of the protective coatings by car repairing after corrosion by a salt environment of the corrosion chamber. The subject of the interest is water-based coatings on steel sheet samples, where they will be one half of the Zn surface layer maintained and the other half of the Zn layer grinded. The material samples examined in several periods exposed to the salt spray in the corrosion chamber. After loading their corrosion resistance will be evaluated of the resistance of the paint coating of the applicable CSN EN standards. At the end of this paper conclusions are drawn and resulting recommendations are presented.

**Keywords:** car repairs, car body, protective coatings, corrosion, degradation.

### Introduction

Corrosion protection is a set of technological measures, the main objective to suitable means to prevent corrosion or at least reduce it to an acceptable level [1; 2]. The secondary objective is the corrosion protection of the resulting aesthetic effect of the protected surface, such as automotive and consumer industries. Currently, we are able today to use all available knowledge about the mechanics and kinetics of corrosion along with the appropriate technical capabilities that can reduce the corrosion losses by up to 25 %.

The most commonly used options include metal corrosion protection of organic coatings. Nowadays, it is increasingly important in creating the most effective corrosion protection of mutual combination of organic with inorganic coatings. Examples of this solution is surface treatment of car bodies, which in part includes inorganic electrolytic zinc plating, phosphating and passivation, then overlaid with a layer of organic coating system.

The issue of paint is very wide. Coating materials are collectively referred to as all materials that are a suitable technique applied to the substrate and which, when applied to the substrate, create a continuous coating film having protective, decorative or special effects. The paints are: film-forming agents, pigments fillers, solvents, tinnings, additives [3; 4].

To reduce environmental impacts transition to water-soluble coating systems currently occurs. The coating systems need to include many other materials used. The most important of these materials are the foundation that creates a suitable environment and the material between the surface of the paint, sealants, which are generally offset by the large surface roughness and filler, used to fill small pores and fine levelling uneven surface of the material. Among the major world producers of coating systems, and the most advanced countries include DuPont, PPG, Standox, Glasurit, Spies Hecker, and Debeer MaxMeyer [3].

The possibilities of coating there are currently numerous. In terms of industrial practice the technology of pneumatic spraying and powder coating is the most important. Pneumatic spray paint has almost universal use in single and mass production in virtually all fields of industry, construction, repair, etc.

Proper surface pre-treatment is an important factor influencing the life of the coating systems [5; 6]. Approximately 75 % of the failure of the protective action of coatings is caused by bad or improperly performed pre-treatment. The type and extent of pre-treatment depends on the chosen technology, the coating material. The main objective of any pre-treatment of the surface is to prepare it to get rid of corrosion products, dirt and prepare the conditions so that it adheres paint well. Pre-treatments by their nature can be divided into two basic groups on the pre-treatment mechanical and chemical. The mechanical pre-treatment includes grinding, polishing, blasting and tumbling. Among the chemical modifications there are radio degreasing, pickling, rust removal and stabilization [3].

In car repairs, we often encounter the need to repair bodywork, while grinding affects victim protection, paint coating to the initial Zn layer base material – steel.

This paper shows an analysis and evaluation of degradation of water-based coating on steel sheet samples which will be on their half of Zn surface layer and maintained in the second half of the Zn layer is removed by grinding.

The process of degradation takes place under laboratory conditions in an artificial atmosphere, which is provided by the standard CSN EN ISO 9227.

The resistance of the coating after corrosion loading by using the macroscopic and visual method will be evaluated. The process and subsequent evaluation of the experiment is governed by the CSN EN standards [7 – 10]. In conclusion, this study will draw conclusions on the behaviour of the protective surfaces in corrosive environments.

### Experimental material

As the test samples the sheets DX 54 + Z were used. This is an electrolytically galvanized sheet metal, pulling deep cold-rolled steel. The nominal thickness is 0.7 mm and its chemical composition, respectively chemical composition of the basic metal without zinc layer, is shown in Table 1. This material is commonly used in the automotive industry. The dimensions of the test piece: 100 x 150 x 0.7 mm.

Table 1

**Chemical composition of material according to EN 10 142**

| Chemical composition, % |        |      |      |     |
|-------------------------|--------|------|------|-----|
| C max                   | Mn max | P    | S    | Ti  |
| 0.02                    | 0.25   | 0.02 | 0.02 | 0.3 |

### Pre-treatment of samples

Surface sampling was conducted using coating system for repair of protective coatings of paint car body from the German company Glasurit. The coating system was applied to the base material according to the technological progress and technical data sheets of the manufacturer. The formation of the protective layer of lacquer was applied with used water-soluble base covered with a layer of clear coat. The whole procedure applying the coating system was divided into four basic steps: degreasing the surface of the sample application without chrome base, pore filler application, final application layer, Fig.1.



**Fig. 1. Preparation of the experimental sample, step by step**

To achieve the final surface treatment the following products were used:

- Stain Remover – KH-Entferner 541-5
- Basis of chromate-free – Echt Primer 283 to 150
- Basis of chromate-free – Como Fuller 285-88
- Water-soluble base – Series AH 90, Tint metallic silver Skoda 9102
- Top clear coat – HS – Universal Klarlac VOC-923-33

Before loading the corrosion samples were identified. Description marking: M – water base was covered with clear lacquer. The number on the second marking indicates the order of removal from the

corrosion chamber. Letters: a – area is the preserved zinc layer, b – area from which the zinc layer has been grinded.

Diagnostic machine Liebisch S 400 M-TR was used to perform load corrosion evaluation. The parameters of corrosion were governed by retraction of the ČSN EN ISO 9227. The exposure time was determined on the basis of empirical experience in the areas of investigation of corrosion protected metal coating load coatings, 100, 190, 270, 350, 430, 510 hours.

### Evaluation of degradation of coated layer

The corrosive load experimental samples were evaluated by a number of established methods and procedures. The most common procedures include the evaluation standards: CSN EN ISO 4628-1-10: Coating materials – Evaluation of degradation of coatings, CSN EN ISO 2409 Coating materials – Cross-cut test.

Evaluation of the degree delamination and corrosion around the cut is one of the methods within the areas of visual assessment. The test was performed according to CSN EN ISO 4628-8, which gives two options for evaluation, according to visual evaluation of the standards, or by calculation. Because for most samples there was no significant peeling paint around the cut, so for all samples assessing the degree of corrosion by the standards was performed, Tab. 2.

Table 2

**Evaluation of corrosion around the the cut according to standards**

| Sample | Exposure time, hour | Degree of corrosion along the cut |
|--------|---------------------|-----------------------------------|
| M1a    | 100                 | No                                |
| M1b    |                     | No                                |
| M2a    | 190                 | No                                |
| M2b    |                     | Grade 2 – Small                   |
| M3a    | 270                 | Grade 1 – Very small              |
| M3b    |                     | Grade 2 – Small                   |
| M4a    | 350                 | Grade 1 – Very small              |
| M4b    |                     | Stage 3 – Moderate                |
| M5a    | 430                 | Grade 2 – Small                   |
| M5b    |                     | Stage 3 – Moderate                |
| M6a    | 510                 | Grade 2 – Small                   |
| M6b    |                     | Stage 3 – Moderate                |

### Cross-cut test

The cross-cut test is used to evaluate the durability of paint peeling from the substrate. It is a further possibility of visual evaluation of the surface samples. The grid standard CSN EN ISO 2409 determines performing the test. For the samples fitted with water-based metallic coating (M1 to M6), there was no defect, and therefore almost all samples were assessed as 0. Only the sample M2a was negligible. Department of the surveyed grid area is probably because of local defects in the coating, Fig. 2, in this case, also with separate metallic filler and lacquer base from scratch.

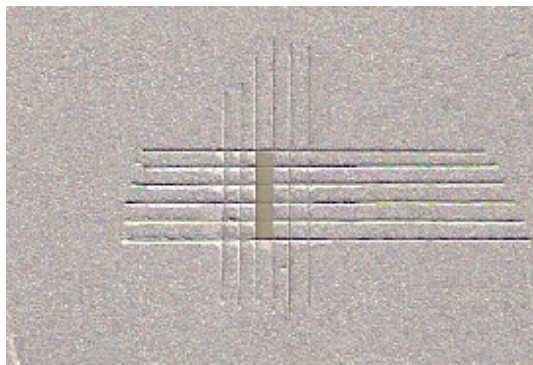


Fig. 2. Paint peeling off after the grid test, sample M2a

The samples provided with the metallic coating layer Zn showed no damage after the test grid, the exception was the sample of M2a, where there was a small defect grid, respectively its partial separation from the substrate. This defect could be caused by the presence of dirty (oily) sites generated during sample handling. Zero degree of damage to the grid was also classified by areas from which the zinc coating polished. In terms of the grid test there is no difference in the behavior of the protective layer deposited on the zinc layer and grinding layer of zinc.

Corrosion around the cut affected the samples with Zn coating after 270 hours exposure. With increasing exposure the range and size of corrosion attack on this layer does not change significantly, it was grade 1 and 2. Due to the low corrosion attack these areas examined did not show delamination. In contrast, the areas from which the Zn layer grinding showed a progressively increasing exposure time increasing the degree of corrosion attack, grade 1 to 4.

Table 3

### Results of analysis degradation of samples after corrosion loading

| Evaluation |   | Exposure Time, hour | Blistering Grade 1-4 | Rusting Grade 1-5 | Delamination Grade 1-5 | Corrosion Grade 1-5 | Cross-cut test Grade 0-5 |
|------------|---|---------------------|----------------------|-------------------|------------------------|---------------------|--------------------------|
| Sample     |   |                     |                      |                   |                        |                     |                          |
| M1         | a | 100                 | *                    | *                 | *                      | *                   | 0                        |
|            | b |                     | *                    | *                 | *                      | *                   | 0                        |
| M2         | a | 190                 | *                    | *                 | *                      | *                   | 1                        |
|            | b |                     | *                    | *                 | *                      | 2                   | 0                        |
| M3         | a | 270                 | *                    | *                 | *                      | 1                   | 0                        |
|            | b |                     | *                    | *                 | *                      | 2                   | 0                        |
| M4         | a | 350                 | *                    | *                 | *                      | 1                   | 0                        |
|            | b |                     | *                    | *                 | *                      | 3                   | 0                        |
| M5         | a | 430                 | *                    | *                 | *                      | 2                   | 0                        |
|            | b |                     | *                    | *                 | *                      | 3                   | 0                        |
| M6         | a | 510                 | *                    | *                 | *                      | 2                   | 0                        |
|            | b |                     | *                    | *                 | *                      | 3                   | 0                        |

Note: \* no defect

Based on the results we can say that the presence of layers of clear lacquer, which have to some extent elastic properties, has a positive impact on the corrosion resistance and resistance to delamination, and the formation of defects after the grind test. Again, the studied samples covered by metallic coating showed good corrosion properties of the zinc layer base material.

### Discussion

Using the mechanism of grind test in practice we could assimilate the phenomenon when small stones fly away from the wheels of a moving car and hit paint on the surface of the body and thereby cause changes in coupling strength between the coating layers and so create is local flaking paint. The presence of the translucent lacquered layer on metallic paint, both on the surface layer of Zn as well as on surface without it, minimizes the problem with separating from the substrate grid significantly.

### Conclusions

The aim of this paper was to evaluate the degradation of coatings for corrosion load neutral salt spray. The experimental part of the paper is devoted to simulate the real conditions existing in the car repair in the repair of protective coatings of car bodies, which occurs when the removal of damaged paint coatings for grinding the initial Zn layer of base material sheet takes place.

Using visual observations of the state of the loaded surface according to the applicable standards found no damage to either the experimental coatings by corrosion or blistering. The samples with a metallic coating with wrong adhesion of the coating demonstrated a tendency to peel. Evaluating the behavior of the coating it is clear that the zinc layer has a significant protective corrosion importance.

The presence of layers of clear lacquer on the samples with metallic coating caused a good resistance to delamination of the coating.

Using water-based coatings in car repairing helps improve environmental protection. Watersoluble coatings, unlike much of acrylic paint, fully comply with the directive of the European Parliament and Council Directive 2004/42/EC on the limitation of emissions of volatile organic compounds – VOCs.

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