# THE INFLUENCE OF SUBSTRATE SURFACE CLEANLINESS ON THE CORROSION RESISTANCE OF COATING SYSTEMS

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**Abstract**

Water-based coating systems are becoming more popular with consumers due to their simple application and a wide range of colours. The coating systems, in addition to the requirement of nice finishes, are supposed to provide the sufficient protection of background material from corrosion. According to manufacturers, some modern water-based coating systems do not require any pre-treatment of the underlying material. In this context it is important to understand what influence avoiding underlying material pre-treatment before subsequent application of coating systems could have in terms of future protection against the effects of corrosive environment. At the boundary of two different environments there can be corrosion products developed, which may cause more hidden corrosion development under certain circumstances. The most frequently ignored corrosion agents include dust.

For protection of the background material the coating system must eliminate those agents effectively. In addition to the aesthetic requirements from consumers, the protection of the background material must also meet environmental aspects. The question is to what extent coating system manufacturers are able to meet these requirements.

**Keywords:** coating systems, corrosion, background material, surface treatment

## 1. INTRODUCTION

Cleanness of surfaces of the base material is one of conditions to ensure corrosion resistance and good adhesiveness of protective coating systems to this material (substrate). In case where residues of dirt adhere on surfaces of the substrate, such as dust particles, this contributes to impaired adhesiveness as well as corrosion resistance of the coat. During application of the coat in the environment where solid dust particles fly in air, these particles adhere both on the substrate and on surfaces of the coat that is not cured yet. This effect of dust particles affects adversely the integrity of the protective coat, support diffusion of the corrosive environment components to the protected surface of the substrate. These adhered solid dust particles may contain various soluble salts and in moist environment, under the protective coat surface, focuses of micro corrosion may appear. In moist environment the soluble substances cause formation of blisters filled with solution of salts, contained in the dust particles. Adhered dust affects protective properties of the coating system. This paper deals possibilities of application of modern coats for short-term corrosion protection based on a thin transparent transport nano-coat applied on a non-ferrous surface, such as galvanised metal sheets, and during transport of metal sheets to the user it has to protect the zinc coat against occurrence of oxidizing fumes formed immediately after contact of the zinc coat with surrounding atmosphere.

## 2. SPECIFICATION OF EXPERIMENTAL MATERIALS

For experimental works there was used:

***Substrate: hot dip galvanized metal sheet***

Dimension of the sample: 150 × 100 × 3 mm.

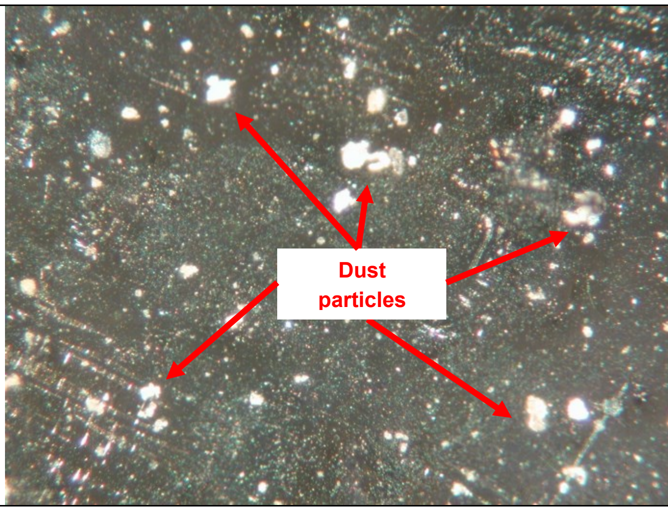
Thickness of the hot dip galvanized coat: average = 92.88 μm, min. = 83 μm, max. = 103 μm.

Measurement of surface roughness: Ra (longitudinal direction) = 5.54 μm, Ra (cross direction) = 5.78 μm, Rz (longitudinal direction) = 28.97 μm, Rz (cross direction) = 30.68 μm. Adjustment of the roughness meter: ISO 1997, ʎc = 0.8, L = 12.5mm. Measuring device: roughness meter Mitutoyo Surftest SJ 301.

***Coating system: transparent transport water-based coating system containing nano-particles.***

Surface of the substrate (zinc coat) was covered with dust. Amount of dust particles before application of the coating system was determined acc. to standard EN ISO 8502-3, using application of a special self-adhesive tape on the substrate. The tape was removed from the surface and adhered onto contract white paper. The result was evaluated acc. to standard EN ISO 8502-3 and can be found in Tab. 1.

**Table 1** Evaluation of dustiness of the surface acc. to standard ISO 8502-3

| Sizes of dust particles | Degree of dustiness | Photo-documentation |
|---|---|---|
| **3** | **4** |  |

## 3. EXPERIMENTAL MEASUREMENTS AND RESULTS

### 3.1. Application of the transparent water-based coating system, technological procedure

**Table 2** Technological procedure for application of the coating system

| | |
|---|---|
| Application method | Brush |
| Dilution of the coating material | 10 % (water from public water mains) |
| Ambient temperature | 22.9 °C |
| Base material temperature | 23.4 °C |
| Relative air humidity | 27.4 % |
| Dew point | 3.5 °C |
| WFT μm – measuring of wet thickness of the paint | 150 to 200 |
| DFT μm – measuring of dry thickness of the paint using a measuring device ELCOMETER 456 | Average thickness = 75.62 μm<br>Min. thickness = 36.70 μm<br>Max. thickness = 106.0 0μm |

### 3.2. Tests of adhesiveness of the coating system, corrosion test

**Table 3** Results of adhesion tests according to EN ISO 16276-1 and EN ISO 16276-2

| Base material | Tear-off strength (MPa) | Characteristics of the break area (%) | Classification degree of the grid test (-) | Classification degree of the cross section (-) |
|---|---|---|---|---|
| *dusty* | 4 | 100% B/Y | 0 | 0 |
| | 5 | 100% B/Y | | |
| | 5 | 10% A/B, 90% B/Y | | |

### 3.3. Corrosion test in artificial atmosphere – salt spray test acc. to EN ISO 9227

The samples were subjected to a corrosion test acc. to standard EN ISO 9227 in a corrosion chamber with salt spray. The samples were provided with cuts 50 mm long. The purpose was to simulate behaviour of the coating system when damaged up to the base material (zinc coat). Duration of the test was fixed to 100 hours, with partial evaluation after 24 hours. The test was evaluated visually acc. to standard EN ISO 4628, parts 2, 3, 4, 5 and 8. Results of the test can be found in Tab. 4.

**Table 4** The evaluation of the corrosion test in artificial atmosphere acc. to standard EN ISO 4628

| Base material | Duration of the test | Rusting through the area acc. to EN ISO 4628-3 | Degree of blistering acc. to EN ISO 4628-2 | Degree of cracking acc. to EN ISO 4628-4 | Coat peeling off acc. to EN ISO 4628-5 | Degree of delamination and corrosion around the cut acc. to EN ISO 4628-8 |
|---|---|---|---|---|---|---|
| | (h) | (degree) | (degree) | (degree) | (degree) | (degree) |
| *Dusty* | 24 | Ri 0 | 0 (S0) | 0 (S0) | 0 (S0) | 0 |
| | 100 | Ri 0 | 5 (S2) | 0 (S0) | 0 (S0) | 0 |

**Fig. 1:** Detail of the dusty substrate surface with a coat after a 100 hours corrosion test

## CONCLUSION

Results of the tests lead to a conclusion that a thin transparent transport coating system with average thickness of 76 microns provided short-term protection of the galvanised substrate surface for a period of 100 hours until occurrence of blisters; this corresponds to anti-corrosion protection for a period of approx. 16 months. The blisters that appeared on the galvanised surface correspond to the dusty surface. Despite the fact that the substrate surface was dusty, the adhesiveness of the coat to the substrate was very good and the anti-corrosion protection was better than mostly required 4 to 6 months specified for transport. Occurrence of corrosion fumes on the zinc coat surface was limited by this coat for the transport period.

## REFERENCES

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