INSTITUT FÜR KORROSIONSSCHUTZ DRESDEN GMBH

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Beratung - Schadensfallaufklärung - Qualitätssicherung - Forschung - Prüfung

- **Prüflabor für Korrosion, Korrosionsschutz und Korrosionsanalytik**
  DAKKS-Registrierungsnummer: **D-PL-19138-01-00**
- Institut im Verbund der Technischen Akademie Wuppertal e. V.
- Institut an der TU Bergakademie Freiberg

☎ 0351 871 7100
Fax 0351 871 7150

Institut für Korrosionsschutz Dresden GmbH • Gostritzer Str. 65 • 01217 Dresden

Test Report

PB300/135/14

Orderer:	ADAPTA COLOR, S. L. Ctra. Nacional 340, Km. 1041.1 12589 PENISCOLA (CATELLON) SPAIN
Date of order:	12.02.2014
Receipt of samples:	24.02.2014
Test period:	26.03.2014 to 04.07.2014
Order:	Testing of a powder coating system on steel in accordance with ISO 12944-6, corrosivitiy category: C5-I, durability: high
Laboratory order No.:	LA3/76/14/143082
Pages:	5
Responsible examiner:	Dr. Stephan Zeltner
Head of laboratory/ Head of department:	Dr. Andrea Rudolf

Institut für Korrosionsschutz Dresden GmbH
Gostritzer Straße 65
01217 Dresden

Dresden, 04.07.2014

created: Dr. Stephan Zeltner	checked: Dr. Andrea Rudolf	approved: Dr. Andrea Rudolf
sign: SZ	sign:	sign:
date: 04.07.2014	date: 07.07.14	date: 07.07.14

1 Test Specimen

The orderer delivered 12 powder-coated test specimens (150 x 100) mm. The following information about the layer building was given by the orderer:

Substrate:	Steel
Surface treatment:	Nano-Phosphate
Coating:	Polyester Anticorrosion Zinc Free (powder coating), Code: RB-7708

The coated plates should be examined in corrosion protection tests according to ISO 12944-6, corrosivity category: C5-I, durability: high.
The corrosion protection system of powder coating is not in the scope of the ISO 12944, nevertheless, are tested usually to this standard.

2 Stress application

The stress application on the test specimens has been carried out in accordance with ISO 12944, part 6 in the following corrosion stress:

- **Continuous condensation in accordance with DIN EN ISO 6270-1**
  The test panels were positioned at an angle of 60° to the horizontal, and a stress of water vapour of 38 °C has been applied on one side (PMK300-3.1). The back sides of the test specimens have been exposed to standard climate 23/50, which resulted in the formation of a temperature gradient along the cross section of the test specimens.

  The duration of the stress was 720 hours.

- **Salt spray according to DIN EN ISO 9227 (NSS)**
  Continuous loading by salt spray (50 g/L NaCl, 35 °C) has been carried out in a salt spray test chamber SC/KWT 1000 (Weiss Umwelttechnik GmbH, PMK300-5.7)

  Before start of the loading a scratch down to the substrate with a distance of 30 mm to the long sides was made on test plates.

  The duration of the stress was 1440 hours.

- **Condensation water saturated atmosphere in the presence of SO_2 in accordance with ISO 3231**
  Test plates were loaded in cycles by condensate water with 0,067 Vol.-% SO_2 (0,2 l) and normal climate. One cycle comprises:

  - 8 hours 40 °C condensation on the test plates, 0,067 Vol.-% SO_2
  - 16 hours 18 °C to 28 °C and 30 to 70 % relative humidity

  The duration of the stress was 30 cycles.

For each test 3 test plates were used.

3 Testing

– Film thickness

The film thickness (prior to stress application) was measured in accordance with DIN EN ISO 2808.

Method:	magnet inductive method 7C
Measuring device:	Fischer DELTASCOPE FMP10
Calibration:	on smooth steel substrate with foils of known thickness

– Visual evaluation

The evaluation of visual changes has been carried out immediately after the end of the stress application.

Degree of blistering:	DIN EN ISO 4628-2
Degree of rusting:	DIN EN ISO 4628-3
Degree of cracking:	DIN EN ISO 4628-4
Degree of flaking:	DIN EN ISO 4628-5

– Cross-cut test

The cross-cut values were determined in accordance with DIN EN ISO 2409. The cross cut was introduced with a cutting tool (1c) prior to stress application and after stress application (24 hours after the removal of the test specimens from the device and storage under laboratory conditions) with a distance between the cuts of 2 or 3 mm (depend on film thickness). Adhesive tape (Tesa 4651) has been unsed.

Gt 0 ...very good adhesive strength
Gt 5 ...very bad adhesive strength

– Determination of corrosion on the scratch after loading by salt spray test

Immediately after the end of loading, the delaminated coating on the scratch was removed with a knife. The maximum width C, in millimeters, of corrosion across the scratch was measured and the corrosion of the substrate from the scratch, M, was calculated by using the following equation:

$$M = \frac{(C - W)}{2}$$

C ... maximum size of the corroded area
W ... width of the original scratch (0,5 mm)

Additionally the corroded and delaminated area was measured in accordance with ISO 4628-8 (average value).

4 Test Results

Assessment prior to stress application		test plate 1	test plate 2	test plate 3
ISO 2808	film thickness / µm	107 ± 14	87 ± 8	81 ± 11
ISO 2409	cross cut value / Gt	0	0	0
Assessment after stress application				
Test 1: ISO 6270-1 (continuous condensation)				
Duration: 720 h		test plate 4	test plate 5	test plate 6
ISO 2808	film thickness / µm	121 ± 18	120 ± 8	108 ± 8
ISO 2409	cross cut value / Gt	0	0	0
ISO 4628-2	degree of blistering	0 (S0)	0 (S0)	0 (S0)
ISO 4628-3	degree of rusting	Ri 0	Ri 0	Ri 0
ISO 4628-4	degree of cracking	0 (S0)	0 (S0)	0 (S0)
ISO 4628-5	degree of flaking	0 (S0)	0 (S0)	0 (S0)
Test 2: ISO 9227 (NSS) (Salt spray test)				
Duration: 1440 h		test plate 7	test plate 8	test plate 9
ISO 2808	film thickness / µm	100 ± 4	97 ± 4	99 ± 9
ISO 2409	cross cut value / Gt	0	0	0
corrosion on scratch	maximum value / mm	0,8	0,8	0,8
ISO 4628-8 (corrosion)*	average value / mm	0,4 ± 0,2	0,4 ± 0,3	0,5 ± 0,2
ISO 4628-8 (delamination)*	average value / mm	0,6 ± 0,2	0,6 ± 0,3	0,7 ± 0,2
ISO 4628-2	degree of blistering	0 (S0)	0 (S0)	0 (S0)
ISO 4628-3	degree of rusting	Ri 0	Ri 0	Ri 0
ISO 4628-4	degree of cracking	0 (S0)	0 (S0)	0 (S0)
ISO 4628-5	degree of flaking	0 (S0)	0 (S0)	0 (S0)
Test 3: ISO 3231 (condensation water with SO_2)				
Duration: 30 cycles		Probe 10	Probe 11	Probe 12
ISO 2808	film thickness / µm	123 ± 9	126 ± 10	126 ± 6
ISO 2409	cross cut value / Gt	0	0	0
ISO 4628-2	degree of blistering	0 (S0)	0 (S0)	0 (S0)
ISO 4628-3	degree of rusting	Ri 0	Ri 0	Ri 0
ISO 4628-4	degree of cracking	0 (S0)	0 (S0)	0 (S0)
ISO 4628-5	degree of flacking	0 (S0)	0 (S0)	0 (S0)

** additionally information*

6 Conclusions from Test Results

Coating systems with film thickness ≤ 250 µm pass the test according to DIN EN ISO 12944-6, if two of three test plates fulfil the following requirements:

<u>Assessment before loading</u>	
Cross-cut according to DIN EN ISO 2409:	≤ 1
<u>Assessment after loading</u>	
Cross-cut according to DIN EN ISO 2409:	≤ 1
Degree of blistering according to DIN EN ISO 4628-2:	0 (S0)
Degree of rusting according to DIN EN ISO 4628-3:	Ri0
Degree of cracking according to DIN EN ISO 4628-4:	0 (S0)
Degree of flaking according to DIN EN ISO 4628-5:	0 (S0)
Corrosion from the scratch (after neutral salt spray test):	≤ 1 mm

The tested coating system on steel fulfils the requirements of DIN EN ISO 12944-6 according to corrosivity category: C 5-I, durability: high.

7 Photographic Documentation

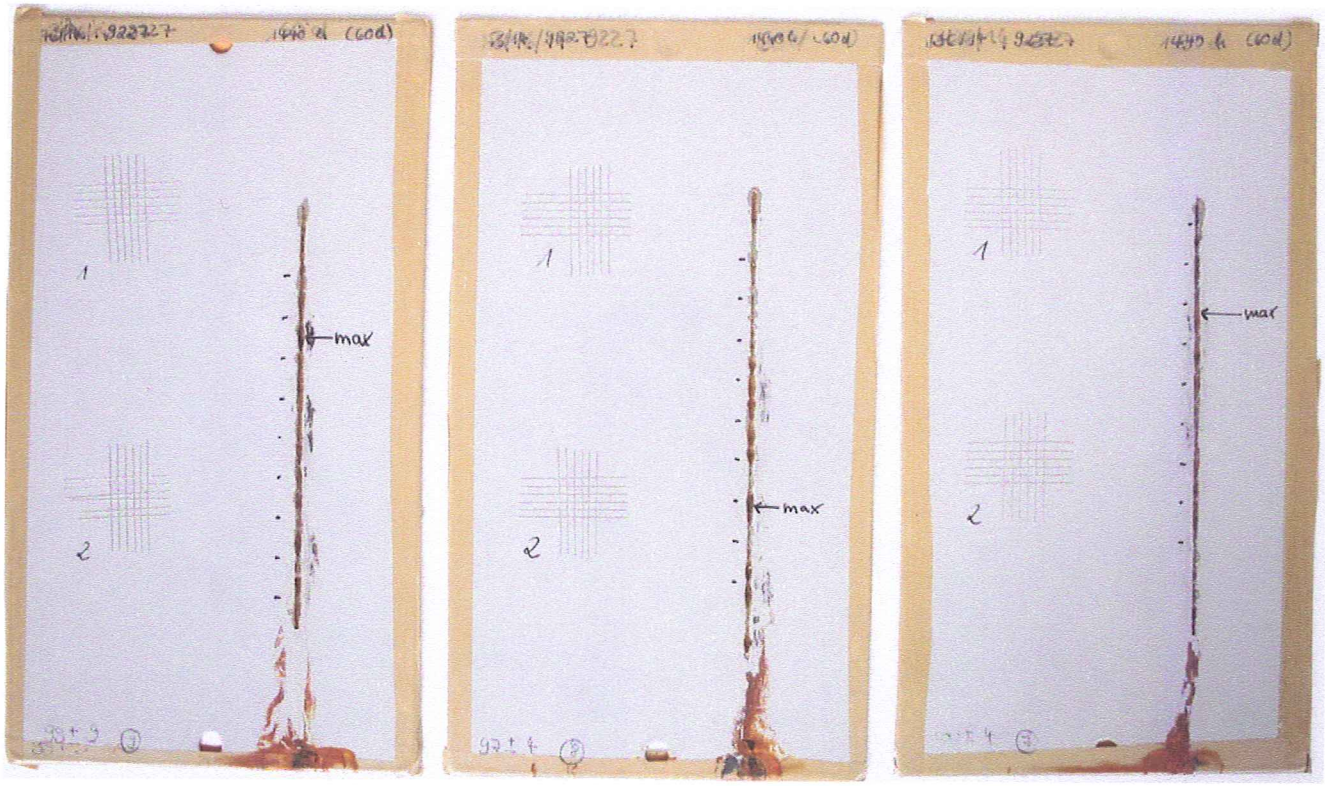

Fig. 1: Test plates after 1440 h salt spray test