CYCLIC CORROSION TEST PROCEDURES

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PROCEDURE 1

OBJECTIVE

The objective of these tests is the determination of the corrosion resistance of various specimens of concrete/coated steel composite samples, subject to climatic changes in a salt-spray test chamber.

The samples to be tested are placed in a controlled aggressive atmosphere which simulates the natural pollution conditions due to chloride ions, exposure to heat and humidity.

TEST PROCEDURES

TEST 1
The program consists of two sequential steps.

Step 1: 18 cycles each of 8 hours, **Fig. 1A**:
- salt spray: 30 min exposure in saline environment at 35±2°C and 1.0±0.1% NaCl pH = 6.5.
- moisture and controlled drying: the samples are exposed to a temperature of 35ºC with 95% RH during 1 h 30 min and then to a temperature of 35ºC with 55% RH during 2 h 30 min.
- drying: 3 h 30 min exposure at 35º C, 20% RH.

Step 2: 3 cycles of 8 hours each, **Fig. 1B**:
- salt spray: 2 h exposure in saline environment at 35±2°C and 1.0±0.1% NaCl pH 6.5.
- drying: samples are exposed to a temperature of 60ºC with 20% RH during 4 h.
- moisture: 2 h exposure at 50º C with 95% RH.

The samples were examined at the end of 6 and 21 cycles with particular attention to the corrosion products on the interfaces, edges and surfaces.

TEST 2
The test involved 63 cycles of 8 hours each, **Fig. 2**, comprised of the following steps:

- salt spray: 2 h exposure is saline environment at 35±2°C and 1.0±0.1% NaCl pH= 6.5.
- moisture: samples are exposed to a temperature of 50ºC with 95% RH during 2 h.
- drying: 4 h exposure to a temperature of 60º C with 20% RH.

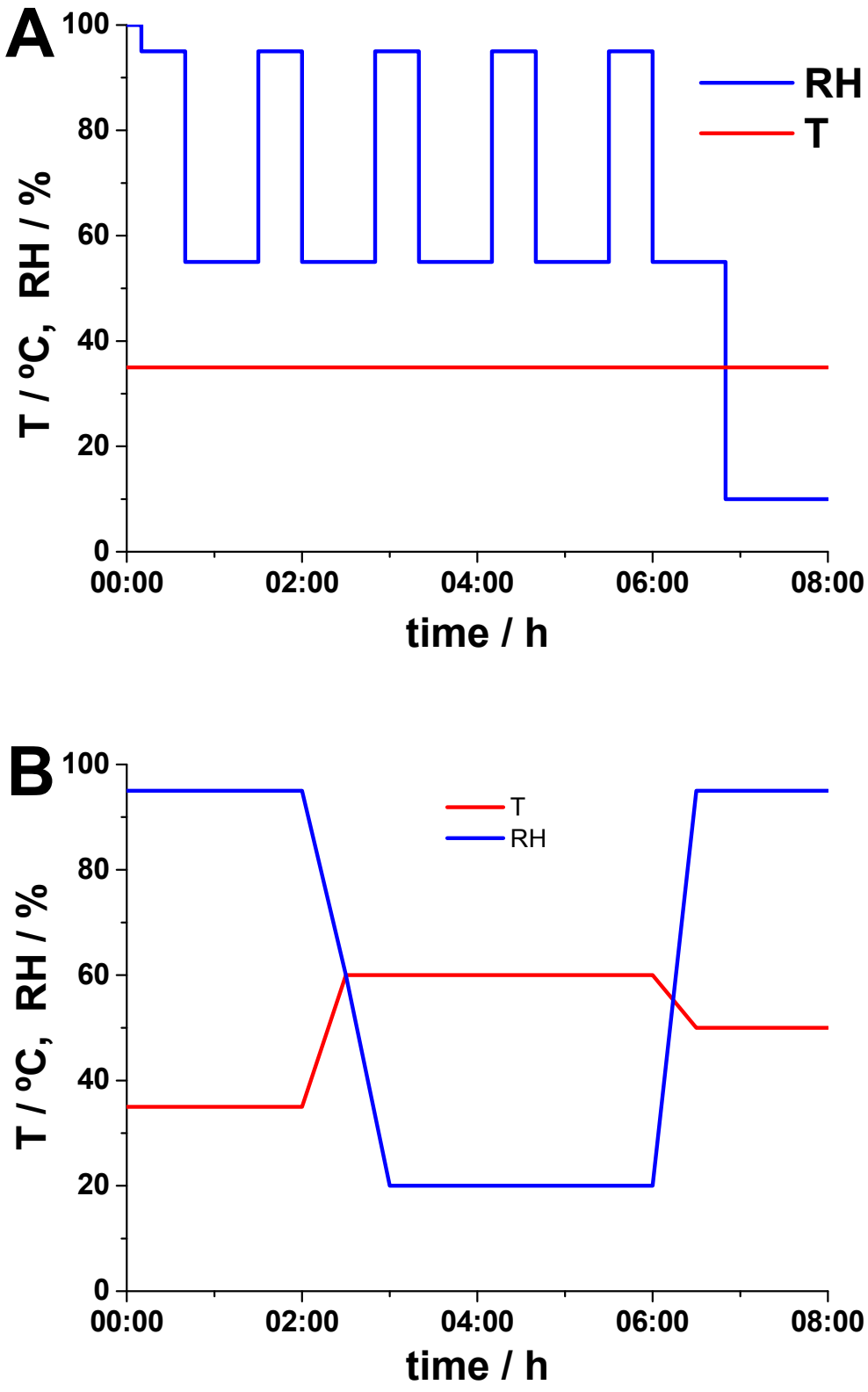

Figure 1 – Test chamber programming for Test 1: **(A)** 1st and **(B)** 2nd step.

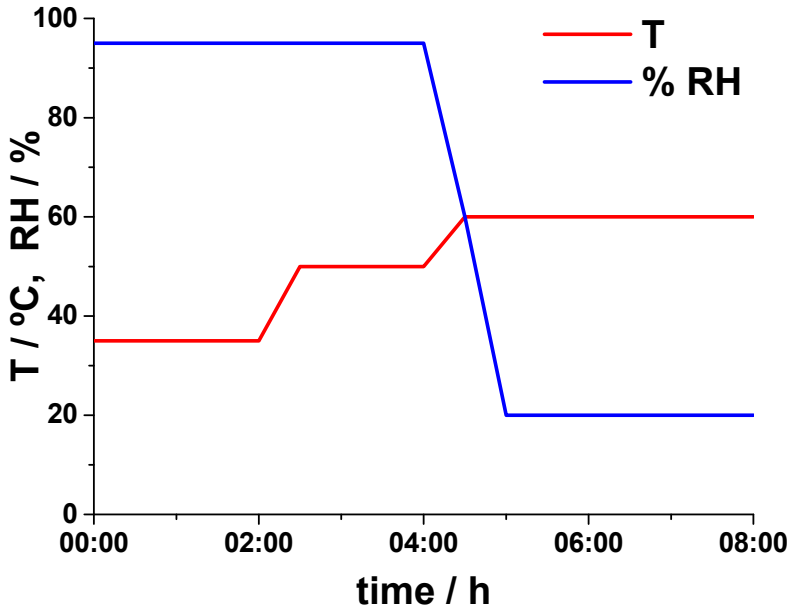

Figure 2 – Test chamber programming for Test 2.

The samples were examined at the end of cycles 9, 21, 30, 48 and 63 with particular attention to the corrosion products on the interfaces, edges and surfaces.

SAMPLE CLEANING AFTER TESTS

Whenever necessary, before examination, samples were rinsed with demineralised water at room temperature and dried with absorbent paper.

ANALYSIS OF THE SAMPLES

The appearance of corrosion at the interfaces, edges and surfaces during the first and second test, can be analysed in a systematic way for each sample type after the chosen numbers of cycles for the first and second test.

PROCEDURE 2

OBJECTIVE

The purpose of this test method is to determine, using climatic change, the corrosion of a film of paint or primer or bonding product, or any other related product, applied on a support. In particular, this method applies to single-layer or multi-layer paint coatings applied to uncoated or pre-coated metal objects.

The test specimens are submitted to a series of attacks in a closely controlled atmosphere simulating the natural pollution conditions due to chloride ions, exposure to hot and humid atmosphere and in ambient atmosphere, as well as drying.

TEST DEFINITION

The test consisted in performing a series of 35 cycles of 24 hours, consisting of the following phases:

- pollution phase: 30 min exposure in the salt spray chamber set to 35°C±2°C and 1%±0,05% sodium chloride pH = 4. The solution pH was adjusted with 0.5 M H_2SO_4.

- phase of moisture and controlled drying: 1h 20 min exposure in the climatic chamber set to 35ºC±2°C and 95%±3% relative humidity, followed by 2h 40min exposure in the climatic chamber set to 35ºC±2°C and 55%±3% relative humidity.
This phase was repeated 5 consecutive times.

- ventilation phase: at the end of the pollution phase, allowing the elimination of fog.

- chamber wall rinsing with demineralized water: in order to avoid the accumulation of salt after the pollution phase, which could result in modifying the degree of humidity.
Note: Spraying of demineralized water on the test specimens was avoided.

The specimens were examined after 14 cycles and after 35 cycles, with respect to:
(1) absence of blistering and red corrosion products on the edge zones
(2) absence of blistering and white corrosion products on the coated zones
(3) lifting of the paint from the metal substrate.

TEST SPECIMEN TREATMENT AND PREPARATION

Specimens are cleaned with distilled water, followed by drying with absorbent paper.
The test specimens are placed on supports, and submitted to 35 cycles in the corrosion chamber as specified in the normative documents.

CLEANING OF TEST SPECIMENS AFTER THE TEST

At the end of the test and before analysis, the specimens are washed lightly with demineralized water at room temperature, then immediately dried using absorbent paper.

PROCEDURE 3

OBJECTIVE

The purpose of this test method is to determine, using climatic change, the corrosion resistance of a film of paint or primer or bonding product, or any other related product, applied to a support.

The coated test specimen are submitted to attack in a perfectly controlled atmosphere simulating the natural pollution conditions due to chloride ions, exposure to hot and humid atmosphere and in ambient atmosphere, as well as drying.

TEST DEFINITION

The test consists in performing a series of 60 one-day-long cycles, consisting of the following phases:

- Phase 1: 4h exposure in the salt spray chamber set to 35°C±2°C and 5%±0.5% sodium chloride (pollution phase) according to DIN 50 021-SS

- Phase 2: 4h exposure to ambient climate in the climatic chamber set to 23°C±1°C and 50% relative humidity according to DIN 50 014-23/50-2

- Phase 3: - 16h exposure in the climatic chamber set to 40°C±1°C and between 95% and 100% relative humidity (heat and high humidity phase) according to DIN 50 017-KK.

TEST SPECIMEN TREATMENT AND PREPARATION

Test specimens are cleaned with distilled water, followed by drying with absorbent paper.

Using a scribing iron two lines 6 cm long are scored on the painted surface of the test specimen, with a depth such that the lines traversed the coating and reach the substrate. The lines are designated as “front” and “back” according to their position on the convex or the concave part of the test specimen. The “front” scribe has a radial direction whereas the “back” one has a transversal direction.

After scribing the test specimen, it was placed on a support, and submitted to 60 cycles as specified in the normative documents.

CLEANING OF TEST SPECIMENS AFTER THE TEST

After 5 and 30 cycles as well as at the end of the test, the test specimen are washed lightly in running water at a temperature not exceeding 37°C, then immediately dried using absorbent paper.

Note: To avoid introducing excessive quantities of sodium chloride that could result in pollution or modify the degree of humidity, from time to time after exposure to salt spray (phase 1) the chamber walls were rinsed with distilled water.

EXPRESSION OF RESULTS IN DAMAGED TEST SPECIMEN (CRITERIA FOR PAINTS AND MASTIC PRODUCTS PROTECTING THE PAINT)

The progress of corrosion under the paint from the damaged area are measured at the end of 5, 30 and 60 cycles. After these corrosion cycles and a minimum of one hour after drying the test specimen, a strip of adhesive tape is carefully applied over the region of the scored line on the "front" of the specimen. The "back" scribe is not submitted to this procedure.

If there are paint blisters, these should be burst by pressing strongly with a plastic rod, without damaging the adhesive tape.

Then the adhesive tape is pulled off with a sharp regular movement. The operation is repeated (with a new strip of adhesive tape) as many times as it is necessary to obtain complete removal of the non-adherent paint at the corroded part.

The degree of corrosion is then measured immediately in terms of (a) the distance between the scribe line and the adherent paint (b) the type of corrosion products.

PROCEDURE 4

OBJECTIVE
The purpose of this test is to test paints and varnishes for their resistance to humidity in condensation-water atmospheres.

TEST DEFINITION
The test consists of cycles of 24 hours.

A constant humidity condensation atmosphere (designation CH) is used at 40±3ºC at 100% relative humidity with condensation on test specimens.
10 cycles of 24 h were carried out (total 240 h).

TEST SPECIMEN TREATMENT AND PREPARATION
The specimen was cleaned with distilled water, followed by drying with absorbent paper.

The test specimen was placed on a support, and submitted to the test in the corrosion chamber as specified in the normative document.

CLEANING OF TEST SPECIMEN AFTER THE TEST
At the end of the test, the specimen was washed lightly with distilled water at room temperature, then immediately dried using absorbent paper.