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Neutral salt spray test — Results of an international interlaboratory test and conclusions for practical application

Essai au brouillard salin neutre — Résultats d'un essai interlaboratoire international et conclusions pour une application pratique

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Foreword

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This document was prepared by Technical Committee ISO/TC 2, *Fasteners*, Subcommittee SC 14, *Surface coatings*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

0.1 General

The neutral salt spray test (NSS test) has been used for at least one century for the corrosion evaluation of various protective layers, including coatings for fasteners. This test is well-known and used worldwide by all involved parties (chemical suppliers, job coaters, manufacturers of components including fasteners, purchasers ...), due to its relatively short testing time compatible with industrial production.

The NSS test is generally considered a suitable method for determining the effectiveness of corrosion protection. The ability to expose samples and components quickly makes it possible to identify weaknesses, pores and damages in organic and inorganic coatings. It is to be noted here that by the use of a salt spray with a defined composition (5 % sodium chloride, NaCl) and by the material-related formation of protection layers there is no direct correlation to other media capable of inducing corrosion. Instead, the results obtained using this method serve to compare different surface conditions under specified and constant conditions. As such, the salt spray test is an effective tool for the quality control of products exposed to corrosive operating conditions.

In terms of the reproducibility of the test results, it is beneficial if the coatings and layers are sufficiently similar. In addition, there are numerous manufacturers that offer different types of salt spray cabinets. The various construction concepts available on the market, as well as factors such as the loading of the cabinet or the use of samples with different geometries, influence the salt spray formation inside the cabinet. This makes it difficult to conduct a comparative assessment of the corrosion test results obtained using different test equipment. For this reason, a project group was established within the Working Group Surface Protection Coating Systems of Deutscher Schraubenverband e.V. with the objective of compiling salt spray test results from as many laboratories as possible and then preparing a comparative assessment.

The samples consisted of bolts that were electrolytically coated using two different zinc-based variants. A total of 39 participants, consisting of bolt manufacturers, job coaters, users and institutes with 75 cabinets from 11 countries were involved in the tests, see Annex A. The large number of participants from all sectors throughout the value chain of a coating process enables a reliable statistical analysis of the test results.

0.2 Executive summary and conclusion

One objective of the interlaboratory test was to conduct a neutral salt spray test in accordance with ISO 9227 on two coating variants of bolts M6×50. Time of occurrence of gray veil, white rust and red rust was documented. The corrosivity of the salt spray was determined by means of assessment of the mass loss of an uncoated steel panel as specified in ISO 9227 as well as the determination of the time until appearance of red rust on hot-dip galvanized steel panels in accordance with ISO 4042 and ISO 10683.

Another objective was to compare the two methods used to determine the corrosivity of the salt spray in order to establish the suitability of these methods by comparing the corrosion assessment results obtained for the bolts.

In addition, the normative operating parameters (temperature in the test cabinet, collection rate, pH and density or NaCl concentration of the solution collected) were documented to ascertain whether there is any correlation with the results of the corrosion assessment performed on the bolts.

The main objective of the interlaboratory test was the determination of the reproducibility of the salt spray test.

A statement has been included in the introduction of the current version of ISO 9227:

“When interpreting test results (e.g. minimum time to damage or corrosion) for product quality control or acceptance specifications, it is important to note that salt spray testing may have low reproducibility, especially for manufacturing parts that are tested in different laboratories.”

These findings are supported by the interlaboratory study. The results are summarized as follows:

— The mass losses of the standardized test panels as per ISO 9227 and the corrosion behaviour of standardized, hot-dip galvanized test panels as per ISO 4042 do not correlate with the corrosion behaviour

observed on the zinc-electroplated and zinc-nickel electroplated bolts M6x50 with transparent or black passivation that were tested in parallel.

— There seems to be no clear connection between the criterion of “compliance with the normative test parameters as per ISO 9227”, which is used to classify the corrosion cabinets as “compliant” or “non-compliant”, and the assessed corrosion behaviour of the test panels or the corrosion behaviour of the bolts tested. Accordingly, compliant operation in line with normative test parameters does not lead to a reduced scatter of the times to failure recorded for the selected coated bolts examined as part of this interlaboratory test.

Additional information about the context to understand these results can be found in Clause 8.

Alternatives to salt spray testing, such as cyclic testing procedures, are established in the market but are mostly customer specific: they need different testing equipment and/or dedicated settings for each type of test (environmental cabinets also need specific skills and experts). Such cyclic tests are useful, however, according to the experience of the committee members, do neither solve the question of correlation between the cabinet parameter settings and the results on tested samples nor of observed scattering of the results.

It is the opinion of the experts that salt spray testing in accordance with ISO 9227 and ISO 4042 should still be applied for:

— production process monitoring and verification for the coating process (but not for process control, especially if based on a statistic approach)

— comparison with different parts using the same coating and the same coating process.

Salt spray testing is however not exhaustive and advantageously accompanied by other tests specified in relevant standards.

Neutral salt spray test — Results of an international interlaboratory test and conclusions for practical application

1 Scope

The objective of this document is to conduct a neutral salt spray test in accordance with ISO 9227. The test is a proven method for assessing the corrosion protection of coatings of components such as bolts. For this reason, two coating variants were chosen for conducting the tests on hexagon bolts with a size of M6 × 50. The bolts were examined at specified points in time and the time of occurrence of grey veil, white rust and red rust was documented. The corrosivity of the salt spray was determined by means of two methods and also documented in an evaluation form. These two methods are the assessment of the mass loss of an uncoated steel panel as specified in ISO 9227 as well as the determination of the time until appearance of red rust on hot-dip galvanized steel panels in accordance with ISO 4042 and ISO 10683.

The processing steps are specified in detail in a manual that was provided to the test participants. If followed precisely, these instructions allow for a comparative analysis of the results from the individual labs and make it possible to determine the reproducibility of the salt spray test. Another objective is to compare the two methods used to determine the corrosivity of the salt spray in order to establish the suitability of these methods by comparing the corrosion assessment results obtained for the bolts. In addition, the normative operating parameters (temperature in the test cabinet, collection rate, pH and density or NaCl concentration of the solution collected) were documented for every inspection date in order to ascertain whether there is any correlation with the results of the corrosion assessment performed on the bolts.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Symbols and abbreviated terms

4.1 Symbols

$F(t)$	Weibull distribution function
b	Shape parameter or Weibull slope
e	Exponential function
k_1	Factor for z_U score
k_2	Factor for z_U score