BRITISH STANDARD

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14977:2006

Copper and copper alloys — Detection of tensile stress — 5 % ammonia test

The European Standard EN 14977:2006 has the status of a British Standard

ICS 77.150.30

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National foreword

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A list of organizations represented on NFE/34 can be obtained on request to its secretary.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document (EN 14977:2006) has been prepared by Technical Committee CEN/TC 133 “Copper and copper alloys”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2006, and conflicting national standards shall be withdrawn at the latest by December 2006.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This test was developed to achieve three aims in particular:

— firstly to avoid health and environmental risks which are associated with the use of media other than ammonia, (e.g. with the use of compounds of mercury and recovery of mercury polluted test pieces), but with a similar sensitivity as the test according to EN ISO 196;

— secondly to combine a test on tensile stress with a test on stress corrosion cracking;

— thirdly to reduce the test duration from usually 24 h, as specified in ISO 6957, to 16 h.

It is not intended to replace and withdraw EN ISO 196 in favour of this standard. In so far as a rapid result is required, the test according to EN ISO 196 can be used.

1 Scope

This standard specifies a medium-duration test using an ammonical atmosphere for the purpose of detecting the presence of tensile stress, residual or applied, in grades of copper or copper-alloy products that might bring about failure of a component in service or storage through stress corrosion cracking.

The field of application of this standard is specified in the technical delivery specifications of semi-finished or finished products in grades of copper and copper alloys, or by prior agreement between purchaser and supplier.

2 Principle

Exposure of test pieces to an ammoniacal atmosphere for 16 h, followed by examination at a magnification of $\times$ 6 to $\times$ 10, e.g. for cracks.

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
stress corrosion cracking
cracking of metals under the combined action of corrosion and tensile stress, residual or applied

3.2
applied stress
tensile stress that is set up and exists in a body during application of an external load

3.3
residual stress
tensile stress that remains within a body as a result of plastic deformation

4 Test solution

4.1 General

Use only reagents of recognised analytical grade and distilled or deionised water for the test solution.

4.2 Test solution No. 1

The test solution is an aqueous solution containing approx. 50 g NH_3 per litre of solution, density at 20 °C: 0,976 g/ml to 0,978 g/ml.

The solution can be used several times, provided that NH_3 concentration is maintained.

4.3 Test solution No. 2

Dissolve 107 g of pure $NH_4C\ell$l, suitable for analysis, in approx. 0,75 l of distilled or deionised water, add a solution of 440 g of NaOH per litre until a pH of 10 ($\pm$ 0,1) at 22 °C is achieved. Dilute the solution with distilled water to one litre. This does not modify significantly the pH. The test solution can be reused several times, provided the pH is checked at least every two weeks, and corrected if necessary.

Because of the consumption of NH_4Cl, after every three months a new test solution shall be prepared.

5 Test pieces

The test pieces shall be at least 150 mm long and shall be degreased. Oxide layers, if any, shall be removed by means of 10 %-sulphuric acid solution (mass fraction), produced by diluting 62 ml of concentrated sulphuric acid (ρ = 1,84 g/ml), with water up to 1 000 ml.

The test pieces shall not be deformed and shall be free from identification stamping or any other mechanical damage. The test pieces shall be dry when the test begins.

6 Procedure

Pour the test solution into a desiccator or an air-tight vessel, maintain the ratio between the volume of the test vessel and the volume of the test solution between 10 : 1 and 20 : 1.

The test pieces shall be arranged in the vessel and above the solution so that the vapour can act from all sides. The test pieces shall neither touch each other nor come into direct contact with the solution.

The test temperature shall be between 20 °C and 25 °C and shall remain constant. The duration of the test shall be 16 h.

At the end of the test period, the test pieces shall be briefly pickled in 10 %-sulphuric acid solution (mass fraction) produced by diluting 62 ml of concentrated sulphuric acid (ρ = 1,84 g/ml), with water up to 1 000 ml or 36 %-nitric acid solution (mass fraction), produced by diluting 440 ml of concentrated nitric acid, (ρ = 1,43 g/ml), with water up to 1 000 ml, dried and examined for cracking under a magnifying glass. The magnification should be between $\times$ 6 and $\times$ 10. Before inspection, it may be necessary to deform the test piece slightly so that fine cracks are opened up and are more readily seen.

Light-gauge test pieces, i.e. pieces with a thickness of less than 2 mm, shall be tested with solution No. 2. Test pieces with a thickness of equal to or greater than 2 mm shall be tested with solution No. 1.

7 Test requirements

The interpretation of the visual appearance of the test pieces (e.g. existence of cracks) after testing is a matter for the product specification and/or has to be agreed between the purchaser and the supplier, e.g. no crack shall be visible on the surface of the test piece when examined under low power magnification.

Cracks within a 5 mm wide zone along cut or sawn edges, or around stamped markings, originating from the test piece preparation shall be disregarded.

8 Test report

The test report shall include the following information:

a) identification of the sample, and the location of the test piece in the sample if the test was carried out on a test piece taken from the sample, rather than on the sample itself;
b) reference of the test method used;
c) pH-value of the solution producing the ammonical atmosphere;
d) exposure temperature;
e) number of replicate test pieces tested;
f) test results: cracks or no cracks (as required in the appropriate product specification);
g) any unusual features noted during the determination;
h) any operation not included in this European Standard or in the document to which reference is made or regarded as optional;
i) date of the test and/or date of preparation or signature of the test report.

Bibliography

In the preparation of this European Standard, use was made of a number of documents for reference purposes. The relevant publications are listed hereafter.

[1] ASTM G 37 – 98, *Standard Practice for Use of Mattsson's Solution of pH 7.2 to Evaluate the Stress-Corrosion Cracking Susceptibility of Copper-Zinc Alloys*

[2] EN ISO 196, *Wrought copper and copper alloys — Detection of residual stress — Mercury(I)nitrate test (ISO 196:1978).*

[3] ISO 6957, *Copper alloys — Ammonia test for stress corrosion resistance.*

[4] Mattsson, E., Holm, R. and Hassel, L.: *Ammonia Test for Stress Corrosion Resistance of Copper Alloys*

[5] Sick, H., *Werkstoffe und Korrosion 38, 356-358 (1978).*

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