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**Paints and varnishes — Cupping test**

*Peintures et vernis — Essai d'emboutissage*

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ISO 1520:1999

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Printed in Switzerland

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 1520 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This second edition cancels and replaces the first edition (ISO 1520:1973), which has been technically revised.

Annex A forms an integral part of this International Standard. Annex B is for information only.

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## Introduction

This International Standard is one of four standards which specify empirical test procedures for assessing the resistance of coatings of paints, varnishes and related products to cracking and/or detachment from the substrate under different conditions of deformation.

The other three documents are:

ISO 1519:1973, *Paints and varnishes — Bend test (cylindrical mandrel)*;

ISO 6272:1993, *Paints and varnishes — Falling-weight test*;

ISO 6860:1984, *Paints and varnishes — Bend test (conical mandrel)*.

The method to be chosen depends on the property which has to be measured and depends on the agreement between interested parties. In principle all these tests technically differ from each other and differ in accuracy.

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# Paints and varnishes — Cupping test

## 1 Scope

This International Standard specifies an empirical test procedure for assessing the resistance of a coating of paint, varnish or related product to cracking and/or detachment from a metal substrate when subjected to gradual deformation by indentation under standard conditions.

For a multi-coat system, each coat may be tested separately or the complete system may be tested.

The method specified may be carried out

- either as a “pass/fail” test, by testing to a specified depth of indentation to assess compliance with a particular requirement;
- or by gradually increasing the depth of indentation to determine the minimum depth at which the coating cracks and/or becomes detached from the substrate.

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## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1512:1991, *Paints and varnishes — Sampling of products in liquid or paste form.*

ISO 1513:1991, *Paints and varnishes — Examination and preparation of samples for testing.*

ISO 1514:1993, *Paints and varnishes — Standard panels for testing.*

ISO 2808:1997, *Paints and varnishes — Determination of film thickness.*

ISO 3270:1984, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing.*

## 3 Principle

The product or system under test is applied at uniform thickness to flat panels of uniform surface texture.

After drying/curing, the elastic properties of the paint film are determined by first placing the coated panel between two rings, namely the retaining ring and the drawing die. The panel is then pushed by a hemispherical indenter at a steady rate into the test piece so as to form a dome shape with the coating on the outside.

The deformation is increased either to a specified depth or until the coating cracks and/or detaches from the substrate, and the result is then assessed.

## 4 Required supplementary information

For any particular application the test method specified in this International Standard needs to be completed by supplementary information. The items of supplementary information are given in annex A.

## 5 Apparatus

**5.1 Cupping test apparatus**, which complies with the design and dimensions shown in figure 1 and consists essentially of the following components:

**5.1.1 Drawing die**, made of surface-hardened steel and of which the surface in contact with the test panel is plane-polished.

**5.1.2 Retaining ring**, of which the surface in contact with the test panel is plane-polished and parallel to the contacting surface of the die.

**5.1.3 Indenter**, of which the part contacting the test panel is of hardened polished steel and forms a hemisphere of 20 mm diameter.

It is preferable to use a mechanically driven indenter, but a hand-operated apparatus is also acceptable, provided that the standard conditions of test (see clause 8) can be achieved.

During the test the indenter shall be prevented from turning and the centre of the spherical portion shall not deviate from the axis of the die by more than 0,1 mm. The indenter shall move at a steady speed of between 0,1 mm/s and 0,3 mm/s during the test.

The tip of the hemisphere, when at the zero position, shall be in the same plane as the face of the retaining ring, in contact with the test panel and in the centre of the bore of the drawing die.

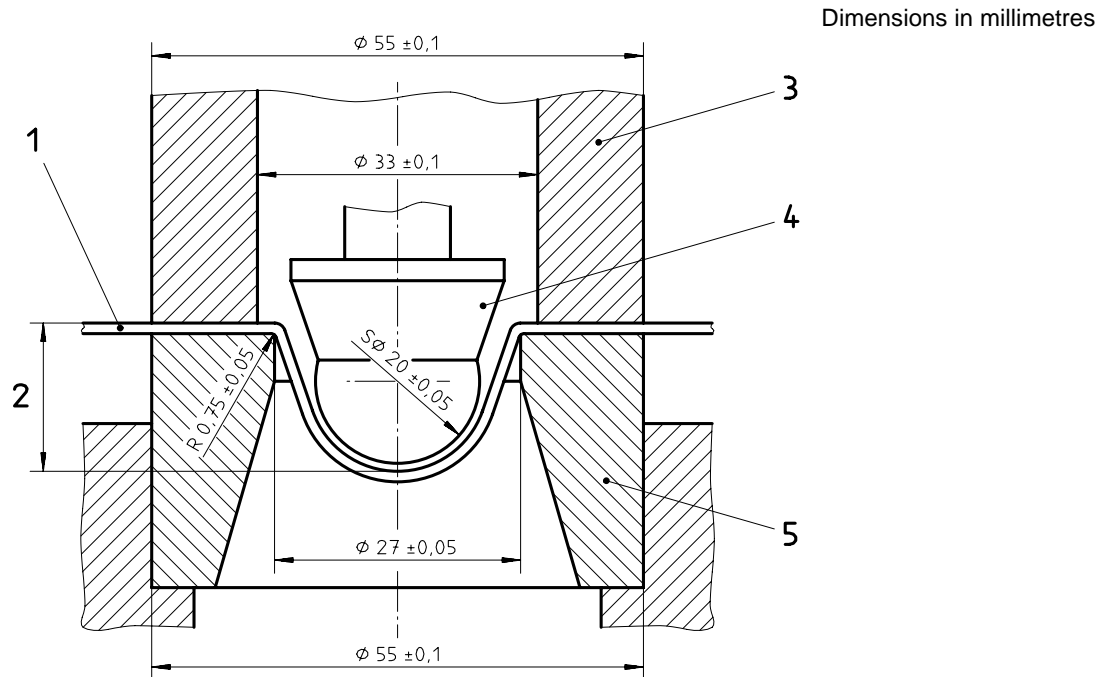
**5.1.4 Measuring device**, which can measure the depth of the indentation made by the indenter to the nearest 0,1 mm.

**5.2 Microscope or magnifier**, preferably with a magnification range extending up to  $\times 10$ , if considered necessary to view the panels during or after deformation.

## 6 Sampling

Take a representative sample of the product to be tested (or of each product in the case of a multi-coat system), as described in ISO 1512.

Examine and prepare each sample for testing, as described in ISO 1513.

**Key**

- 1 Test panel  
2 Depth of indentation  
3 Retaining ring

- 4 Indenter and ball  
5 Die

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**7 Test panels****7.1 Substrate**

Unless otherwise agreed, select the substrate from one of those described in ISO 1514 and, where possible, in accordance with the intended use.

The test panels shall be flat and free from distortion and capable of withstanding the cupping test without cracking.

**NOTE** If cracking of the substrate occurs before the cracking and/or detachment of the paint film, the test result of the paint film can be reported to be better than the indentation depth at which cracking of the substrate occurred.

**7.2 Dimensions**

The test panels shall be rectangular with the following dimensions:

- thickness: not less than 0,3 mm and not more than 1,25 mm (as specified and measured with a micrometer (5.1.4) to the nearest 0,01 mm);
- width and length: three tests shall be carried out either on a single long strip or on three separate panels. The indentation centres of the tests shall be at least 35 mm from any edge and the distance between any two centres shall be a minimum of 70 mm. The test panels may be cut to size after coating and drying, provided no distortion occurs.

**7.3 Preparation and coating**

Unless otherwise agreed, prepare each test panel in accordance with ISO 1514 and then coat it by the specified method with the product or system under test.

## 7.4 Drying and conditioning

Dry (or stove) and age (if applicable) each coated test panel for the specified time and under the specified conditions. Unless otherwise agreed, condition the coated panels at  $(23 \pm 2)$  °C and a relative humidity of  $(50 \pm 5)$  % for a minimum period of 16 h before testing.

## 7.5 Thickness of coating

Determine the thickness, in micrometres, of the dried coating by one of the procedures specified in ISO 2808.

# 8 Procedure

## 8.1 Test conditions

Carry out the test in triplicate at  $(23 \pm 2)$  °C and a relative humidity of  $(50 \pm 5)$  %, unless otherwise agreed (see also ISO 3270).

## 8.2 Procedure for a single specified depth of indentation

**8.2.1** Carry out the following procedure in triplicate (if the results differ, additional tests shall be made).

**8.2.2** Hold the test panel firmly without excessive pressure between the retaining ring (5.1.2) and the drawing die (5.1.1) with the coating towards the die and with the hemispherical end of the indenter (5.1.3) just in contact with the uncoated side of the test panel (zero position of the indenter). Adjust the panel until the central axis of the indenter intersects the panel at least 35 mm from the edge.

**8.2.3** Advance the hemispherical end of the indenter into the test piece at a steady rate between 0,1 mm/s and 0,3 mm/s until the specified depth is reached, i.e. until the indenter has travelled this distance from the zero position.

**8.2.4** Using normal corrected vision or, by agreement, a microscope or magnifier of  $\times 10$  magnification (5.2), examine the coating of the test panel for cracking and/or detachment from the substrate.

**NOTE** If a microscope or magnifier is used, it is essential to mention this fact in the test report to avoid misleading comparisons with results obtained using normal vision only.

Carry out the procedure given in 8.2 until, using normal corrected vision (or, by agreement, a microscope or magnifier of  $\times 10$  magnification), a crack is first observed on the surface of the coating and/or the coating begins to become detached from the substrate. Stop the indenter at this point and measure the depth of indentation (see figure 1) to the nearest 0,1 mm, i.e. the distance travelled by the indenter from the zero position. Confirm the result by repeating the determination on two fresh panels (if the results differ, further determinations shall be made).

## 9 Expression of results

The test results shall be reported as either:

- whether or not the coating on the test panels passed the specified indentation depth;
- or the maximum depth of indentation at which the coating passed, obtained from the calculation of the mean of three valid results (triplicates) and to the nearest 0,1 mm.

## 10 Precision

See annex B.

## 8.3 Procedure for determination of minimum depth of indentation to cause failure



## 11 Test report

The test report shall include the following information:

- a) all details necessary to identify the product tested;
- b) a reference to this International Standard (ISO 1520:1998);
- c) the items of supplementary information referred to in annex A;
- d) a reference to the international or national standard, product specification or other document supplying the information referred to in c);
- e) the results of the test as indicated in clause 9;
- f) whether the defects were assessed using normal corrected vision or a microscope or magnifier and, if this was used, the magnification setting at which it was used;
- g) whether a hand-operated or a mechanically driven apparatus was used;
- h) any deviation from the test method specified;
- i) the date of the test.

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