INTERNATIONAL STANDARD

ISO 6441-1

First edition
1999-12-15

Paints and varnishes — Determination of micro-indentation hardness —

Part 1: Knoop hardness by measurement of indentation length

Peintures et vernis — Détermination de la dureté par micro-indentation — Partie 1: Dureté Knoop par mesurage de la longeur d'indentation

Reference number
ISO 6441-1:1999(E)

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Printed in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this part of ISO 6441 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6441-1 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

Together with the other parts (see below), it cancels and replaces ISO 6441:1984, which has been technically revised.

ISO 6441 consists of the following parts, under the general title *Paints and varnishes — Determination of micro-indentation hardness:*

— *Part 1: Knoop hardness by measurement of indentation length*

— *Part 2: Knoop hardness by measurement of indentation depth under load*

— *Part 3: Creep and visco-elastic properties and elastic modulus using the Vickers indenter*

Annex A forms a normative part of this part of ISO 6441.

Introduction

This part of ISO 6441 is one of three dealing with the determination of the micro-indentation hardness of a dried film of paint, varnish or related product.

Part 1 specifies a method in which the hardness is calculated from the length, measured using a microscope, of a long diagonal of the indentation made by a Knoop indenter.

In this method, the indentation length is measured after the indenter has been removed.

Part 2 specifies a method in which the hardness is calculated from the depth, measured using an electronic technique, of the indentation made by a Knoop indenter.

In this method, the indentation depth is measured while the indenter is still under load.

Part 3 specifies a method in which the hardness, creep, visco-elasticity and modulus of elasticity are determined by measuring the depth of the indentation made by a Vickers indenter as a function of time.

Other methods have been standardized to measure the hardness of a paint film:

— ISO 1518, *Scratch test.*

— ISO 15184, *Determination of film hardness by pencil test.*

— ISO 2815, *Buchholz indentation test.*

— ISO 1522, *Pendulum damping test.*

The method chosen depends on the property which is to be measured. All these tests differ from each other technically, and in their accuracy. They also range from fairly simple to rather sophisticated, with the instruments prescribed in ISO 6441, part 1, part 2 and part 3, being of a sophisticated nature.

Paints and varnishes — Determination of micro-indentation hardness —

Part 1: Knoop hardness by measurement of indentation length

1 Scope

This part of ISO 6441 is one of a series of standards dealing with the sampling and testing of paints, varnishes and related products.

It specifies a method for determining the hardness of a dried film of a paint, varnish or related product by conducting an indentation test in which the indentation length is measured under zero-load conditions using a microscope.

It is applicable to single-coat and multicoat systems.

The result is expressed as a hardness value, in N/mm², calculated from the indentation produced by a pyramidal indenter of a specified size and shape applied to the coating under specified conditions.

This method is similar to Test Method A of ASTM D 1474-92 (see reference [1] in the Bibliography).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6441. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6441 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1513:1992, *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.*

ISO 15528:—[1)], *Paints, varnishes and raw materials for paints and varnishes — Sampling.*

1) To be published. (Revision of ISO 842:1984 and ISO 1512:1991)

3 Principle

The hardness of the surface of a dried paint or varnish film is measured, under specific conditions, with a pyramidal indenter (Knoop indenter) fitted to a micro-hardness tester.

The Knoop hardness is defined as the applied load divided by the projected area of the indentation in the plane of the surface of the paint film (see Figure 3).

During the test, the Knoop indenter is kept under a specified load for (18 ± 0,5) s. After removal of the indenter, the length of the indentation is measured.

From this length, the area of the indentation in the plane of the surface of the paint film is calculated, and hence the Knoop hardness.

This method is applicable provided that the indentation depth does not exceed approximately 25 % of the coating thickness.

Exceeding this limit will result in the substrate influencing the penetration depth.

Further, the hardness value of the coating can be influenced (lowered) by a substrate material of much lower hardness than the coating.

4 Required supplementary information

For any particular application, the test method specified in this part of ISO 6441 needs to be completed by supplementary information. The items of supplementary information are given in annex A.

5 Apparatus

5.1 Hardness tester, including a Knoop indenter (5.1.1) and a microscope (5.1.2). This apparatus shall be capable of:

— Bringing the indenter into contact with the test surface at a specified speed, in accordance with the manufacturer's instructions, with negligible impact under a nearly zero load. Any impact by the indenter on the test surface will result in errors in readings and the calculated hardness will be too low.

— Progressively applying a selected load to the indenter and maintaining the load for (18 ± 0,5) s.

— Removing the load and withdrawing the indenter from the test surface.

— Measuring the length of the indentation by a microscope.

NOTE Several types of (electronic) apparatus are available commercially and may be used, provided that they can be shown to give similar results.

5.1.1 Knoop indenter: a pyramidal diamond with a longitudinal included angle at the vertex of 172° 30' and a transverse included angle of 130° (see Figure 1).

The four faces shall be equally inclined to the axis of the indenter (within ± 0,2°) and shall meet at the vertex, any offset between opposite faces not exceeding 1 µm (the usual shape of the point as it would appear under high magnification is shown in Figure 2).

NOTE 1 The ratio of the long diagonal to the short diagonal of the indentation is approximately 7:1; the ratio of the long diagonal to the depth of penetration is approximately 30:1.

NOTE 2 The manufacturer normally provides with each indenter a certificate stating the dimensions of the indenter. The certificate also gives the indenter constant, calculated from the dimensions.

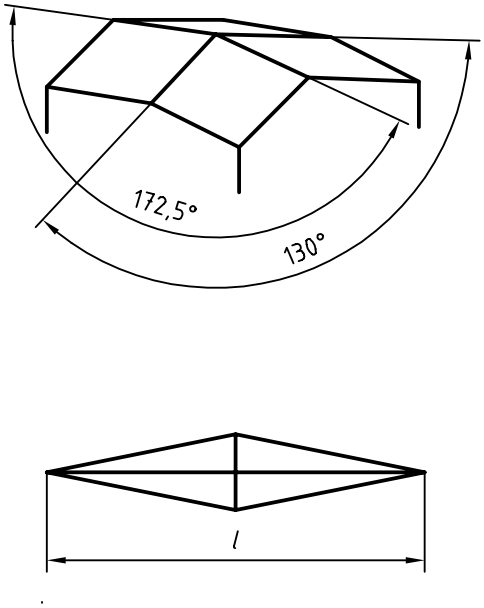
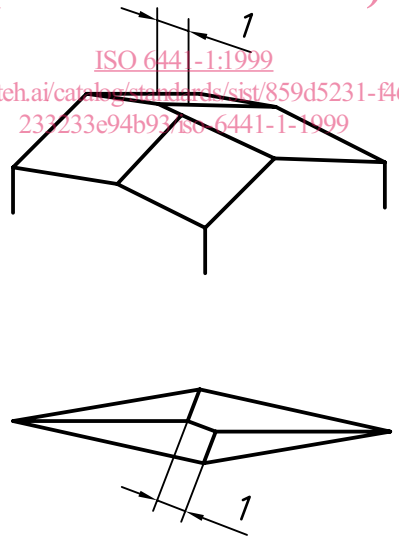


Figure 1 — Knoop indenter



Key

1 Offset (1 µm max.)

Figure 2 — Indenter offset