INTERNATIONAL STANDARD

ISO 4545

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Metallic materials — Hardness test — Knoop test

Matériaux métalliques — Essai de dureté — Essai Knoop

Reference number
ISO 4545:1993(E)

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 4545 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Sub-Committee SC 3, *Hardness testing*.

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Metallic materials — Hardness test — Knoop test

1 Scope

This International Standard specifies the method of Knoop hardness test for metallic materials. It covers test forces up to and including 9,807 N.

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 4546:1993, *Metallic materials — Hardness test — Verification of Knoop hardness testing machines.*

ISO 10250:—[1], *Metallic materials — Hardness test — Tables of Knoop hardness values for use in tests made on flat surfaces.*

3 Principle

Forcing a diamond indenter, in the form of a rhombic-based pyramid with specified angles between opposite faces at the vertex, into the surface of a test piece and measuring the long diagonal of the indentation left in the surface after removal of the test force, F. (See figures 1 and 2.)

The Knoop hardness is proportional to the quotient obtained by dividing the test force by the projected area of the indentation which is assumed to be a rhombic-based pyramid, and having at the vertex the same angles as the indenter.

4 Symbols and designations

4.1 See table 1 and figures 1 and 2.

4.2 The Knoop hardness is denoted by the symbol HK preceded by the hardness value and supplemented by

a) a number representing the test force (see table 2);

b) the duration of loading, in seconds, if different from the time specified in 7.4.

EXAMPLES

640 HK 0,1 = Knoop hardness of 640 determined with a test force of 0,980 7 N applied for 10 s to 15 s

640 HK 0,1/20 = Knoop hardness of 640 determined with a test force of 0,980 7 N applied for 20 s

5 Apparatus

5.1 Test machine, capable of applying a predetermined force or forces from $98,07 \times 10^{-3}$ N to 9,807 N, in accordance with ISO 4546.

5.2 Indenter, a diamond in the shape of a rhombic-based pyramid, as specified in ISO 4546.

5.3 Measuring device, as specified in ISO 4546.

1) To be published.

Table 1

Symbol	Designation
F	Test force, in newtons
d	Length, in millimetres, of the long diagonal
c	Indenter constant, relating projected area of the indentation to the square of the length of the long diagonal
HK	Knoop hardness $= \text{Constant} \times \frac{\text{Test force}}{\text{Projected area of indentation}}$ $= 0{,}102 \times \frac{F}{d^2 \cdot c} = 0{,}102 \times \frac{F}{0{,}070\ 28\ d^2} = 1{,}451\ \frac{F}{d^2}$
NOTE	Constant $= \frac{1}{g_n} = \frac{1}{9{,}806\ 65} \approx 0{,}102$ Indenter constant $c = \frac{\tan \frac{\beta}{2}}{2 \tan \frac{\alpha}{2}}$ where α and β are the angles between the opposite edges.

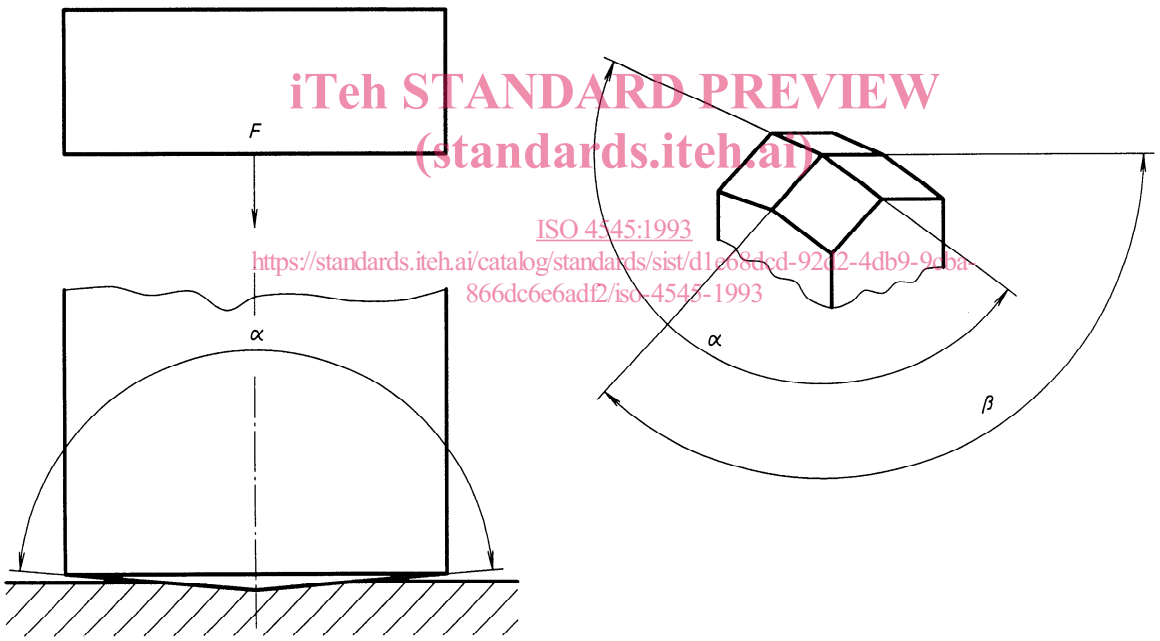

Figure 1 — Knoop indenter

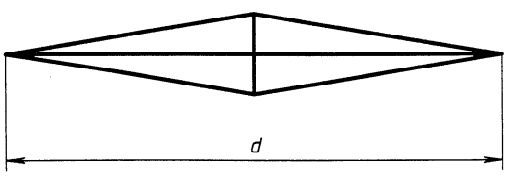

Figure 2 — Knoop indentation

6 Test piece

6.1 The test shall be carried out on a polished surface which is smooth and even, free from oxide scale and foreign matter and, in particular, completely free from lubricants. In all tests the perimeter of the indentation shall be clearly defined in the field of the microscope.

6.2 Due to the small depth of Knoop hardness indentations, special precautions must be taken during preparation. Preparation shall be carried out in such a way that any alteration of the surface hardness, due to heat or cold-work, for example, is minimized.

6.3 No deformation shall be visible at the back of the test piece after the test.

6.4 For test pieces of small cross-section or of irregular shape, it may be necessary to provide some form of additional support, for example mounting in plastic material.

7 Test procedure

7.1 The test is normally carried out at a temperature of 23 °C ± 5 °C. If the test is carried out at a temperature outside this range, it shall be noted in the test report.

7.2 The test forces given in table 2 are recommended.

Table 2

Hardness symbol	Nominal test force, F N
HK 0,01	$98{,}07 \times 10^{-3}$
HK 0,02	0,196 1
HK 0,025	0,245 2
HK 0,05	0,490 3
HK 0,1	0,980 7
HK 0,2	1,961
HK 0,3	2,942
HK 0,5	4,903
HK 1	9,807

7.3 The test piece shall be placed on a rigid support. The contact surfaces shall be clean and free from foreign matter (scale, oil, dirt, etc.). It is important that the test piece lies firmly on the support so that displacement cannot occur during the test. The ends of the diagonal of the indentation must be clearly defined.

7.4 Bring the indenter into contact with the test surface and apply the test force in a direction perpendicular to the surface, without shock or vibration, until the applied force attains the specified value. The time from the initial application of the force until the full test force is reached shall not exceed 10 s. The approach velocity of the indenter shall be within the range 15 µm/s to 70 µm/s. The duration of the test force shall be from 10 s to 15 s. For certain materials, a longer time for maintaining the force is provided; this time shall be applied with a tolerance of ± 2 s.

7.5 Throughout the test, the apparatus shall be protected from shock or vibration.

7.6 The minimum distance between the limit of any indentation and the edge of the test piece shall be at least 2,5 times the short diagonal of the indentation in the case of steel, copper and copper alloys and at least three times the short diagonal of the indentation in the case of light metals, lead and tin and their alloys.

The minimum distance between the limits of two adjacent indentations shall be at least three times the short diagonal of the indentation in the case of steel, copper and copper alloys, and at least six times the short diagonal in the case of light metals, lead and tin and their alloys. If two adjacent indentations differ in size, the minimum spacing shall be based on the short diagonal of the larger indentation.

7.7 The length of the long diagonal shall be measured and used for the calculation of the Knoop hardness.

7.8 Attention is drawn to ISO 10250, which contains a table of values for use in tests made on flat surfaces.

8 Test report

The test report shall include the following information:

a) reference to this International Standard;

b) all information necessary for identification of the test sample;

c) the result obtained;

d) all operations not specified by this International Standard or regarded as optional;

e) details of any circumstances which may have affected the result.

NOTES

1 There is no general process of accurately converting Knoop hardness values into other scales of hardness or into tensile strength. Such conversions therefore should be avoided, unless a reliable basis for conversion can be obtained by comparison tests.

2 A strict comparison of hardness values is only possible at identical test forces.

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