TC 164

International Standard 146

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Metallic materials — Hardness test — Verification of Vickers hardness testing machines HV 0,2 to HV 100

Matériaux métalliques — Essai de dureté — Contrôle des machines d'essai de dureté Vickers HV 0,2 *à* HV 100

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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It cancels and replaces ISO Recommendation R 146-1968, of which it constitutes a technical revision.

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Metallic materials — Hardness test — Verification of Vickers hardness testing machines HV 0,2 to HV 100

1 Scope and field of application

This International Standard specifies a method of verification of testing machines for determining Vickers hardness HV 0,2 to HV 100 (test forces from 1,961 to 980,7 N) in accordance with ISO 6507/1 and ISO 6507/2.

It describes a direct verification method for checking the main functions of the machine, and an indirect verification method suitable for the overall checking of the machine. The indirect verification method may be used on its own for periodic routine checking of the machine in service.

If a testing machine is also to be used for other methods of hardness testing, it shall be verified independently for each method.

2 References

ISO 409, *Metallic materials — Hardness test — Tables of Vickers hardness values for use in tests made on flat surfaces —*

Part 1: HV 5 *to* HV 100.

Part 2: HV 0,2 *to less than* HV 5. [1]

ISO 640, *Metallic materials — Hardness test — Calibration of standardized blocks to be used for Vickers hardness testing machines* HV 0,2 *to* HV 100. [2]

ISO 3878, *Hardmetals — Vickers hardness test.* [3]

ISO 6507, *Metallic materials — Hardness test — Vickers test —*

Part 1: HV 5 *to* HV 100.

Part 2: HV 0,2 *to less than* HV 5.

3 General conditions

Before a Vickers hardness testing machine is verified, it shall be checked to ensure that

— the machine is properly set up;

— the plunger holding the indenter is capable of sliding in its guide, by its own weight, but without any appreciable clearance;

— the indenter-holder is firmly mounted in the plunger;

— the test force can be applied and removed without shock or vibration and in such a manner that the readings are not influenced;

— if the measuring device is integral with the machine

— the change from removing the test force to measuring mode does not influence the readings,

— illumination does not affect the readings,

— the centre of the indentation is in the centre of the field of view.

The illumination device of the measuring microscope shall produce uniform lighting of the whole observed field and maximum contrast between the indentation and the surrounding surface.

4 Direct verification

Direct verification involves

— verification of the test force;

— verification of the indenter;

— verification of the measuring device.

1) At present of the stage of draft. (Partial revision of ISO/R 409-1964.)

2) At present of the stage of draft. (Partial revision of ISO/R 640-1967.)

3) At present of the stage of draft. (Partial revision of ISO 3878-1976.)

4.1 Verification of the test force

4.1.1 Each test force used (chosen from table 1) within the working range of the testing machine, shall be measured, and, whenever applicable, this shall be done at not less than three positions of the plunger uniformly spaced throughout its range of movement during testing.

4.1.2 The test force shall be measured by one of the following two methods:

a) measuring by means of an elastic proving device previously calibrated to an accuracy of ± 0,2 %;

b) balancing against a force, accurate to ± 0,2 % applied by means of standardized masses with mechanical advantage.

4.1.3 Three readings shall be taken for each test force at each position of the plunger. Immediately before each reading is taken, the plunger shall have been moved in the same direction as during testing.

4.1.4 Each measurement of the force shall be within ± 1,0 % of the nominal value of the test force, as given in table 1.

Table 1

Hardness symbol	Nominal test force, F N
HV 0,2	1,961
HV 0,3	2,942
HV 0,5	4,903
HV 1	9,807
HV 2	19,61
HV 2,5	24,52
HV 3	29,42
HV 5	49,03
HV 10	98,07
HV 20	196,1
HV 30	294,2
HV 50	490,3
HV 100	980,7

4.2 Verification of the indenter

4.2.1 The four faces of the square-based diamond pyramid shall be polished and free from surface defects.

4.2.2 The verification of the shape of the indenter can be made by direct measurement or by measurement of its projection on a screen.

4.2.3 The angle between the opposite faces at the vertex of the diamond pyramid shall be 136 ± 0,5°. See figure 1.

4.2.4 The inclination of the axis of the diamond pyramid to the axis of the indenter holder (normal to the seating surface) shall be within 0,5°. The four faces shall meet in a point, any line of junction between opposite faces being

- less than 0,001 mm for HV 0,2 to less than HV 1;
- less than 0,002 mm for HV 1 to HV 100.

See figure 2.

4.3 Verification of the measuring device

4.3.1 The estimation capability required of the measuring device depends on the size of the smallest indentation to be measured.

The scale of the measuring device shall be graduated to permit estimation of the diagonals of the indentation in accordance with table 2.

Table 2

Diagonal d mm	Estimation capability
$0,02 \leqslant d < 0,1$	± 1 % of d
$0,1 \leqslant d < 0,2$	± 0,001 mm
$d \geqslant 0,2$	± 0,5 % of d

NOTE — Estimation capacity of the measuring device for Vickers hardness testing of hardmetals is specified in ISO 3878.

4.3.2 The measuring device shall be verified by measurements made on a stage micrometer at a minimum of five intervals over each working range.

The maximum error shall not exceed the values given in table 3.

Table 3

Diagonal d mm	Maximum permissible error
$0,02 \leqslant d < 0,05$	± 0,000 5 mm
$0,05 \leqslant d < 0,1$	± 1 % of d
$0,1 \leqslant d < 0,2$	± 0,001 mm
$d \geqslant 0,2$	± 0,5 % of d

5 Indirect verification

Indirect verification may be carried out by means of standardized blocks calibrated in accordance with ISO 640.

5.1 Procedure

5.1.1 For the indirect verification of a testing machine, the following procedures shall be applied.

When verifying testing machines using several test forces, at least two forces shall be chosen. One of the forces shall be the test force most frequently used. For each test force chosen, two standardized blocks shall be chosen from two different hardness ranges specified below. The forces and blocks shall be chosen so that at least one standardized block in each hardness range shall be used for the verification.

⩽ 225 HV

400 to 600 HV

> 700 HV

5.1.2 When verifying testing machines using only one test force, three standardized blocks shall be used, one in each of the ranges specified in 5.1.1.

5.1.3 For special purposes, a hardness testing machine may be verified at one hardness value only, corresponding approximately to that of the tests to be made.

5.1.4 On each standardized block, five indentations shall be made and measured. The test shall be made in accordance with ISO 6507/1 or ISO 6507/2.

Attention is drawn to ISO 409/1 and ISO 409/2 which contain calculation tables for use in tests made on flat surfaces.

5.1.5 For each standardized block, let d_1, d_2, . . . , d_5, be the arithmetic mean values of the measured two diagonals of the indentations, arranged in increasing order of magnitude.

5.2 Repeatability

5.2.1 The repeatability of the testing machine under the particular verification conditions is determined by the difference

$$d_5 - d_1$$

5.2.2 The repeatability of the testing machine verified is not considered satisfactory unless it satisfies the conditions given in table 4.

Table 4

Hardness of the standardized block	Repeatability of the testing machine, max.		Examples of equivalent hardnesses	
	HV 0,2 to less than HV 5	HV 5 to HV 100	HV 0,2 to less than HV 5	HV 5 to HV 100
⩽ 225 HV	0,06 $\bar{d}$ 1)	0,04 $\bar{d}$	12 at 100 24 at 200	8 at 100 16 at 200
> 225 to 400 HV	0,03 $\bar{d}$	0,02 $\bar{d}$	15 at 250 21 at 350	10 at 250 14 at 350
> 400 HV	0,04 $\bar{d}$	0,03 $\bar{d}$	48 at 600 60 at 750	36 at 600 45 at 750

1) The value of $\bar{d}$ is given by the formula

$$\frac{d_1 + d_2 + \ldots + d_5}{5}$$

5.3 Error

5.3.1 The error of the testing machine under the particular verification conditions is characterized by the difference:

$$\bar{H} - H$$

where

$$\bar{H} = \frac{H_1 + H_2 + \ldots + H_5}{5}$$

in which

$H_1, H_2, \ldots, H_5$ are the hardness values corresponding to $d_1, d_2, \ldots, d_5$;

H is the specified hardness of the standardized block used.

5.3.2 The maximum error of the testing machine, expressed as a percentage of the specified hardness of the standardized block, shall not exceed the values given in table 5.

6 Test report

The test report shall contain the following information:

a) reference to this International Standard;

b) method of verification (direct or indirect);

c) identification data of the hardness testing machine;

d) means of verification (test blocks, elastic proving devices, etc.);

e) the test force used;

f) the result obtained;

g) date of verification and reference to the testing institution.

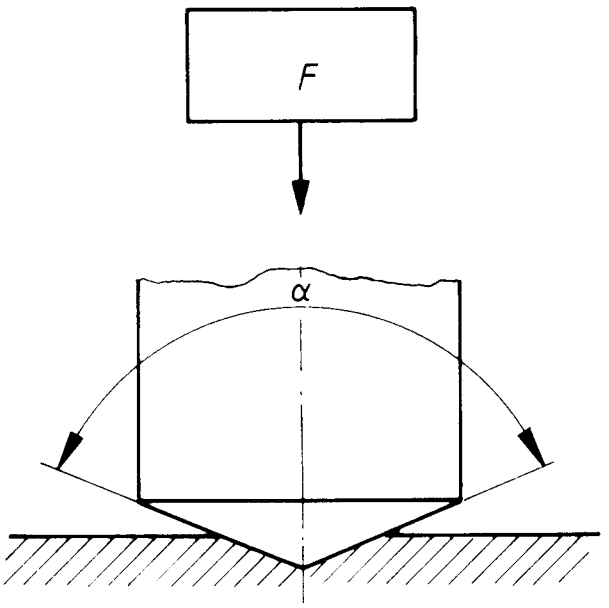
Table 5

Hardness symbol	Maximum permissible error, expressed as a percentage of the specified hardness HV of the standardized block used										
	100	200	300	400	500	600	700	800	900	1 000	1 500
HV 0,2	5	6	8	9	10	11	11	12	12	–	–
HV 0,3	4	5	6	7	8	9	10	10	11	11	–
HV 0,5	4	5	5	6	6	7	7	8	8	9	11
HV 1	3	4	4	4	5	5	5	6	6	6	8
HV 2	3	3	3	4	4	4	4	4	5	5	6
HV 2,5	3	3	3	3	4	4	4	4	4	5	5
HV 3	3	3	3	3	3	4	4	4	4	4	5
HV 5	3	3	3	3	3	3	3	3	3	4	4
HV 10	3	3	3	3	3	3	3	3	3	3	3
HV 20	3	3	3	3	3	3	3	3	3	3	3
HV 30	2	2	2	2	2	2	2	2	2	2	2
HV 50	2	2	2	2	2	2	2	2	2	2	2
HV 100	2	2	2	2	2	2	2	2	2	2	2

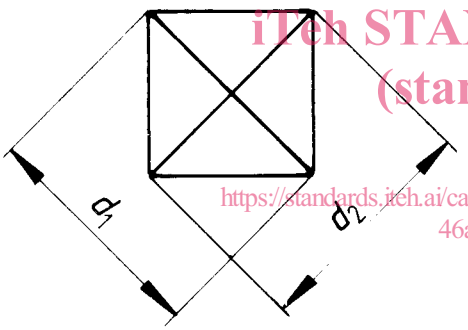
NOTES

1 Values are not given when the indentation diagonal is less than 0,020 mm.

2 For intermediate values the maximum permissible error may be obtained by interpolation.



Indenter (diamond pyramid)



Vickers indentation

Figure 1

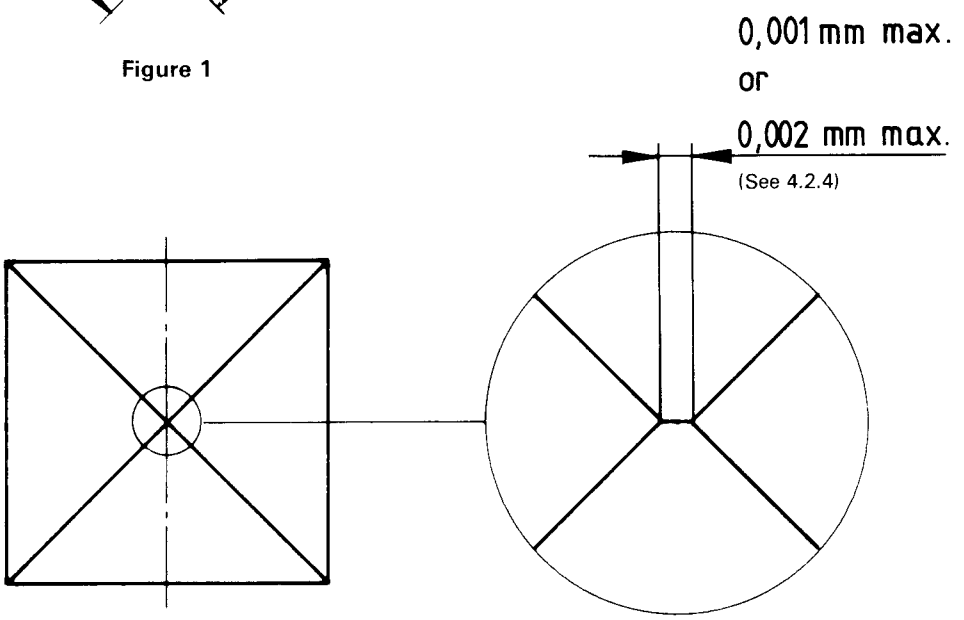


Figure 2