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Rubber, vulcanized or thermoplastic — Determination of dead-load hardness using the very low rubber hardness (VLRH) scale

Caoutchouc vulcanisé ou thermoplastique — Détermination de la dureté sous charge constante au moyen de l'échelle de très faible dureté (VLRH)

Reference number
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Contents

Page

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.

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The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 27588 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This second edition cancels and replaces the first edition (ISO 27588:2008), which has been revised to include a calibration schedule for the apparatus used (see Annex B).

Introduction

The hardness test specified in this International Standard is intended as a more discriminating alternative to the international rubber hardness degrees scale (ISO 48) for rubbers below 35 IRHD. A durometer method for soft rubbers is described in ISO 7619-1 as the AO scale. Examples of applications are low-modulus bearings, soft roller coverings and printing rubbers.

Figure 1 shows a comparison of the ranges of the IRHD N and IRHD L methods in ISO 48 with the VLRH scale of this International Standard.

The methods differ primarily in the diameter of the indenting ball and the magnitude of the indenting force, these being chosen to suit the particular application.

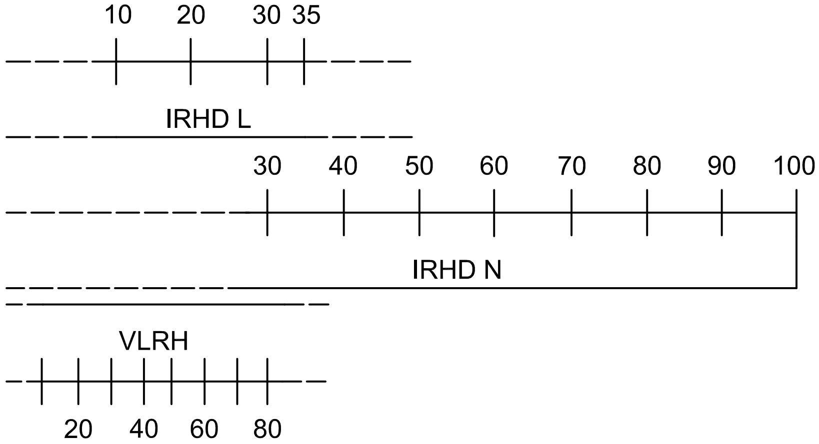

Figure 1 — Comparison of the ranges of hardness measurement methods for rubber

Rubber, vulcanized or thermoplastic — Determination of dead-load hardness using the very low rubber hardness (VLRH) scale

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This International Standard specifies a dead-load method for the determination of the hardness of very soft vulcanized or thermoplastic rubbers using the very low rubber hardness (VLRH) scale.

The relation between the depth of penetration and the VLRH scale is linear.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18898:2012, *Rubber — Calibration and verification of hardness testers*

ISO 18899, *Rubber — Guide to the calibration of test equipment*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Principle

The hardness test consists of measuring the difference between the depths of indentation of a ball into the rubber under a small contact force and a large total force. From this difference, the hardness in “very low rubber hardness degrees” (VLRH) is obtained using Table A.1 (see Annex A) or graphs based on this table or a scale, reading directly in very low rubber hardness degrees, calculated from the tables and fitted to the indentation-measuring instrument.

4 Apparatus

The essential parts of the apparatus are as follows, the appropriate dimensions and forces being shown in Table 1. Detailed information can be found in References [1] and [2].

4.1 Vertically guided plunger, having a ball or spherical surface on the lower end, and means for supporting the plunger so that the spherical tip is kept slightly above the surface of the annular foot prior to applying the contact force.

4.2 Means for applying a contact force and an additional indenting force to the plunger, making allowance for the mass of the plunger, including any fittings attached to it, and for the force of any spring acting on it, so that the forces actually transmitted through the spherical end of the plunger are as specified.

4.3 Means for measuring the increase in depth of indentation of the plunger caused by the indenting force, either in millimetres with a maximum uncertainty of 0,001 mm, or reading directly in VLRH with a resolution such that a reading to at least 0,5 VLRH is possible.

4.4 Flat annular foot, normal to the axis of the plunger and having a central hole for the passage of the plunger. The foot rests on the test piece and shall be rigidly connected to the indentation measurement device so that a measurement is made of the movement of the plunger relative to the foot (i.e. the top surface of the test piece), not relative to the surface supporting the test piece.

If it is required that measurements be made on test pieces with a curved surface, a calibration has to be carried out. Tests need to be made on test pieces of the material with both flat and curved surfaces. The hardness difference ($H_{\text{curved}} - H_{\text{flat}}$) which is found for the flat and the curved test pieces is used with opposite sign as correction of the hardness values obtained on test pieces of a similar material with a curved surface.

4.5 Measuring table, as support for the test piece. The measuring table shall be flat and normal to the axis of the plunger.

Table 1 — Nominal values and tolerances of forces and diameters

Force on ball			Force on foot mN
Contact mN	**Indenting** mN	**Total** mN	
8,3 ± 0,5	91,7 ± 0,5	100,0 ± 1,0	235 ± 30

Diameter mm		
Ball	Foot	Hole
2,50 ± 0,01	6,0 ± 0,5	3,0 ± 0,1

5 Calibration

The requirements for calibration of the test apparatus are given in Annex B.

6 Test pieces

The test pieces shall be prepared in accordance with ISO 23529.

The test pieces shall have their upper and lower surfaces flat, smooth and parallel to one another.

The standard test piece shall be a minimum of 6 mm thick and shall be made up of one, two or three layers of rubber, the thinnest of which shall not be less than 2 mm. The lateral dimensions of the test piece shall be such that three or more measurements can be made at least 10 mm from each other and at least 3 mm from the edges of the test piece.

Test pieces of other dimensions or from finished products may be used but will usually produce results which differ from those obtained with standard test pieces.

7 Time interval between forming the test pieces and testing

The time interval between forming the test pieces and testing shall be in accordance with ISO 23529.

8 Conditioning

The test pieces shall be maintained at a standard laboratory temperature (see ISO 23529) for a minimum of 3 h immediately before testing.

9 Temperature of test

The test shall be carried out at the same standard laboratory temperature as was used for the conditioning.

10 Procedure

Place a test piece on the horizontal measuring table. Bring the foot into contact with the surface of the test piece. Press the plunger and indenting ball onto the rubber for 5 s, the force on the ball being the contact force.

If the gauge is graduated in VLRH degrees, adjust it to read 100 at the end of the 5 s period. Then apply the additional indenting force and maintain it for 30 s, when a direct reading of hardness in VLRH degrees is obtained.

If the gauge is graduated in millimetres, note the differential indentation of the plunger caused by the additional indenting force, applied for 30 s. Convert this to VLRH degrees by using Table A.1 or a graph constructed therefrom.

Repeat the test to obtain measurements at three different locations on the test piece, observing the requirements for separation distances given in Clause 6. Take the median of the three results as the result of the test.

11 Test report

The test report shall include the following information:

a) sample and test piece details:

   1) a full description of the sample and its origin,

   2) compound details and cure details, where appropriate,

   3) the dimensions of the test piece,

   4) the number of layers in the test piece and the thickness of the thinnest layer,

   5) in the case of curved or irregularly shaped test pieces, a description of the test piece,

   6) the method of preparation of the test pieces from the sample, e.g. by moulding or cutting;

b) test method:

   1) a reference to the test method used, i.e. the number of this International Standard,

   2) for curved test pieces, the way in which the test piece was mounted and the way the test force was applied;

c) test details:

   1) the time and temperature of conditioning prior to the test,

   2) the temperature of test, and the relative humidity, if necessary,

   3) details of any procedures not specified in this International Standard;

d) test result:

   1) the number of test pieces tested,

   2) the individual test results,

   3) the median result, e.g. 15 VLRH;

e) the date of the test.

Annex A
(normative)

Relationship between indentation depth and hardness, and derivation of the VLRH scale

As described in Clause 3, the hardness test measures the difference, D, between the depths of indentation of a ball into the rubber under a small contact force and a large total force. From this difference, the hardness in very low rubber hardness degrees (VLRH) is obtained. Table A.1 shows the conversion of values of D to very low rubber hardness degrees (VLRH).

Table A.1 — Conversion of values of D to very low rubber hardness degrees (VLRH)

D µm	VLRH	D µm	VLRH	D µm	VLRH
0	100	340	66	680	32
10	99	350	65	690	31
20	98	360	64	700	30
30	97	370	63	710	29
40	96	380	62	720	28
50	95	390	61	730	27
60	94	400	60	740	26
70	93	410	59	750	25
80	92	420	58	760	24
90	91	430	57	770	23
100	90	440	56	780	22
110	89	450	55	790	21
120	88	460	54	800	20
130	87	470	53	810	19
140	86	480	52	820	18
150	85	490	51	830	17
160	84	500	50	840	16
170	83	510	49	850	15
180	82	520	48	860	14
190	81	530	47	870	13
200	80	540	46	880	12
210	79	550	45	890	11
220	78	560	44	900	10
230	77	570	43	910	9
240	76	580	42	920	8
250	75	590	41	930	7
260	74	600	40	940	6
270	73	610	39	950	5
280	72	620	38	960	4
290	71	630	37	970	3
300	70	640	36	980	2
310	69	650	35	990	1
320	68	660	34	1 000	0
330	67	670	33		

The general mathematical relationship between the depth of penetration, D, and VLRH is given by the equation:

$$\mathrm{VLRH} = 100 - 0{,}1D \quad (1)$$

Figure A.1 gives a graphical representation of this relationship.

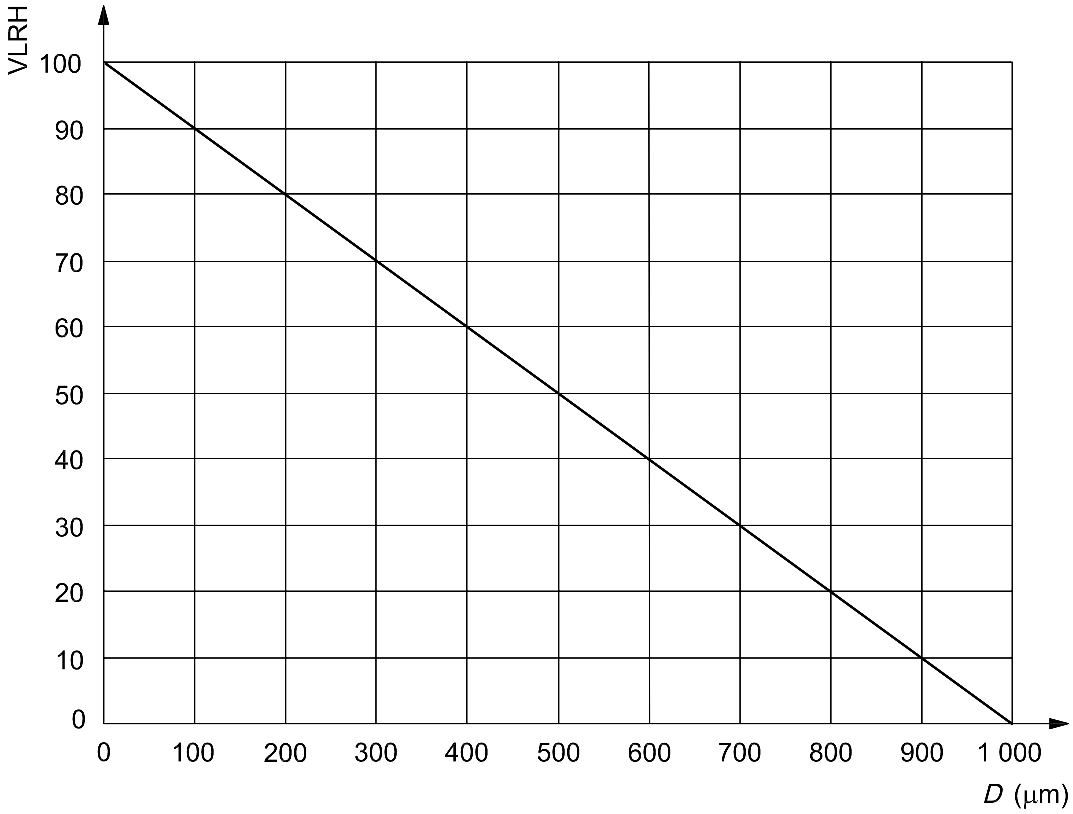

Figure A.1 — Relationship between the depth of penetration, D, and VLRH

Annex B
(normative)

Calibration schedule

B.1 Inspection

Before any calibration is undertaken, the condition of the items to be calibrated shall be ascertained by inspection and recorded in any calibration report or certificate. It shall be reported whether calibration is made in the “as-received”condition or after rectification of any abnormality or fault.

It shall be ascertained that the apparatus is generally fit for the intended purpose, including any parameters specified as approximate and for which the apparatus does not therefore need to be formally calibrated. If such parameters are liable to change, then the need for periodic checks shall be written into the detailed calibration procedures.

B.2 Schedule

Verification/calibration of the test apparatus is a normative part of this International Standard. However, the frequency of calibration and the procedures used are, unless otherwise stated, at the discretion of the individual laboratory, using ISO 18898 (for the parameters listed in Table B.1) or ISO 18899 (for the additional items listed below Table B.1) for guidance.

The calibration schedule given in Table B.1 has been compiled by listing all of the parameters specified in the test method for the apparatus, together with the specified requirement. A parameter and requirement can relate to the main test apparatus, to part of that apparatus or to an ancillary apparatus necessary for the test.

For each parameter, a calibration procedure is indicated by reference to ISO 18898, to another publication or to a procedure particular to the test method which is detailed (whenever a calibration procedure which is more specific or detailed than that in ISO 18898 is available, it shall be used in preference).

The verification frequency for each parameter is given by a code-letter. The code-letters used in the calibration schedule are:

C requirement to be confirmed but no measurement;

N initial verification only;

S standard interval as advised in ISO 18899;

U in use.

Table B.1 — Calibration frequency schedule

Parameter	Requirement	Subclause in ISO 18898:2012	Verification frequency guide	Notes
Ball diameter of indentor	2,50 mm ± 0,01 mm	5.2.1.1	S	
Centrality of pressure foot	Central	C	N	
Diameter of pressure foot	6,0 mm ± 0,5 mm	5.2.2.1	N	
Hole diameter of pressure foot	3,0 mm ± 0,1 mm	5.2.2.2	N	
Force on pressure foot	235 mN ± 30 mN	5.2.4	S	
Difference, D, between depths of indentation under contact force and under total force	$D = f$(VLRH) (see Table A.1) ΔD = 0,001 mm	5.2.3	S	ISO 18898 uses the symbol l rather than D for the difference in indentation depths.
Contact force on indentor	8,3 mN ± 0,5 mN	5.2.6	S	
Additional force on indentor	91,7 mN ± 0,5 mN	5.2.6	S	
Duration of application of force	Contact force: 5 s Total force: 30 s	5.2.7	U	

In addition to the items listed in Table B.1, use of the following is implied, all of which need calibrating in accordance with ISO 18899:

— a timer;

— a thermometer for monitoring the conditioning and test temperatures;

— instruments for determining dimensions of the test pieces.

Bibliography

[1] HERRMANN, K., STROBEL, P., STIBLER, A.: Neues Härtemessverfahren für sehr weiche Elastomere — Untersuchung und Einführung des Verfahrens IRHD SUPERSOFT, *Materialprüfung*, **44** (2002) 3, pp. 83-86

[2] STROBEL, P., HERRMANN, K.: Very Low Rubber Hardness, *Kautschuk Gummi Kunststoffe (KGK)*, **59** (2006) 7/8, pp. 377-381

[3] ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

[4] ISO 7619-1, *Rubber, vulcanized or thermoplastic — Determination of indentation hardness — Part 1: Durometer method (Shore hardness)*

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