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INTERNATIONAL STANDARD 1400

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Vulcanized rubbers of high hardness (85 to 100 IRHD) – Determination of hardness

Caoutchoucs vulcanisés de haute dureté (85 à 100 D_IDC) – Détermination de la dureté

Kor.

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; these documents are now in the process of being transformed into International Standards. As part of this process, Technical Committee ISO/TC 45 has reviewed ISO Recommendation R 1400 and found it technically suitable for transformation. International Standard ISO 1400 therefore replaces ISO Recommendation R 1400-1971 to which it is technically identical.

ISO Recommendation R 1400 was approved by the Member Bodies of the following countries :

Australia	Hungary	Spain
Austria	India	Sweden
Canada	Iran	Switzerland
Colombia	Israel	Thailand
Czechoslovakia	Italy	Turkey
Egypt, Arab Rep. of	Netherlands	United Kingdom
France	New Zealand	U.S.S.R.
Germany	Poland	

No Member Body expressed disapproval of the Recommendation.

No Member Body disapproved the transformation of ISO/R 1400 into an International Standard.

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Vulcanized rubbers of high hardness (85 to 100 IRHD) – Determination of hardness

0 INTRODUCTION

The hardness test specified in this International Standard is based on the measurement of the indentation of a rigid ball into a rubber test piece under specified conditions and is for use with rubbers in the upper end of the hardness scale specified in ISO 48, *Vulcanized rubbers – Determination of hardness (Hardness between 30 and 85 IRHD)*, that is, for rubbers of hardness greater than 85 international rubber hardness degrees (IRHD). For such rubbers it is desirable to increase the indentation for a given hardness above that produced in the normal test so that better discrimination between the harder rubbers is possible. For this purpose a smaller indentor should be used than that required for the normal method of ISO 48, with the same indenting force, preferably with a more sensitive method of measuring the indentation.

The measured indentation is converted into international rubber hardness degrees, the scale of degrees being so chosen that 0 represents the hardness of a material having an elasticity modulus of zero and 100 represents the hardness of a material of infinite elasticity modulus.

For substantially elastic isotropic materials like well-vulcanized natural rubbers, the hardness in international rubber hardness degrees bears a known relation to Young's modulus, although for markedly plastic or anisotropic rubbers the relationship will be less precisely known.

This International Standard at present only gives details of a normal test method but a scaled-down (micro-test) procedure may be added for use with thinner material as has been done in ISO 48.

NOTE – The value of hardness obtained by this method within the range 80 to 95 IRHD may not agree precisely with that obtained using the method of ISO 48. The difference is not normally significant for technical purposes. The reference method for hardness within this range shall be that of ISO 48.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method for the determination of the hardness of vulcanized rubbers with hardness in the range 85 to 100 IRHD.

The range of applicability of this and other ISO hardness test methods for vulcanized rubbers is indicated in figure 1.

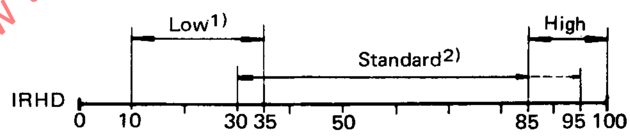

FIGURE 1 – **Range of applicability of hardness tests**

2 REFERENCE

ISO/R 471, *Standard atmospheres for the conditioning and testing of rubber test pieces.*

3 PRINCIPLE

The hardness test consists in measuring the difference between the depths of indentation of the ball into the rubber under a small contact force and a large total force. From this difference, the hardness in international rubber hardness degrees (IRHD) is derived by using either table 3 or a graph based on this table, or a scale reading directly in international rubber hardness degrees and derived from the table, fitted to the indentation-measuring instrument.

1) See ISO 1818.

2) See ISO 48.

The relation between the difference of indentation and the hardness expressed in international rubber hardness degrees is based on

a) the known relation, for a perfectly elastic isotropic material, between indentation P, expressed in hundredths of a millimetre, and Young's modulus M, expressed in meganewtons per square metre, namely :

$$\frac{F}{M} = 0{,}003\,8\, R^{0{,}65}\, P^{1{,}35}\,*$$

where

F is the indenting force, expressed in newtons;

R is the radius of the ball, expressed in millimetres;

b) the use of a probit (integrated normal error) curve to relate $\log_{10} M$ to the hardness in international rubber hardness degrees; the relevant section of this curve is shown in figure 2. This curve is defined by :

1) *the value to* $\log_{10} M$ *corresponding to the midpoint of the curve*
= 0,364 (M being expressed in meganewtons per square metre);

2) *the maximum slope*
= 57 international rubber hardness degrees per unit increase in $\log_{10} M$.

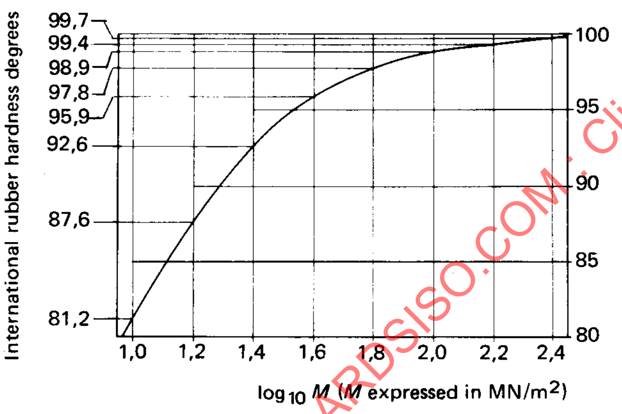

FIGURE 2 – **Relation of $\log_{10} M$ to hardness in international rubber hardness degrees**

4 APPARATUS

The essential parts of the apparatus are as follows, the appropriate dimensions and forces being shown in table 1 :

4.1 Vertical plunger having a rigid 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 weight 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 shall be as specified.

4.3 Means for measuring the increase in depth of indentation of the plunger caused by the indenting force, either in metric units or reading directly in IRHD. The means employed may be mechanical, optical or electrical.

NOTE – A dial gauge having a travel of 0,5 mm per revolution is suggested.

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 exerts a pressure on it of 30 ± 5 kN/m², provided the total load on the foot does not fall outside the values given in table 1. The foot shall be rigidly connected to the indentation-measuring 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.

4.5 Means for gently vibrating the apparatus, for example an electrically operated buzzer, to overcome any slight friction. (This may be omitted in instruments where friction is completely eliminated.)

4.6 Chamber for the test piece when tests are made at temperatures other than a standard laboratory temperature. This chamber shall be equipped with a means of maintaining the temperature within 2 °C of the desired value. The foot and vertical plunger shall extend through the top of the

TABLE 1 – **Forces and dimensions of apparatus**

Diameters	**Force on ball**			**Force on foot**
	Contact	**Indenting**	**Total**	
mm	N	N	N	N
ball 1,00 ± 0,01 foot 20 ± 2 hole 6 ± 2	0,30 ± 0,02	5,40 ± 0,01	5,70 ± 0,03	8,3 ± 1,5

NOTE – Not all possible combinations of dimensions and forces in table 1 will meet the pressure requirements of 4.4.

* This formula is approximate and is included as an indication.

chamber, and the portion passing through the top shall be constructed from a material having a low thermal conductivity. A sensing device shall be located within the chamber, near or at the location of the test piece, for measuring the temperature.

5 TEST PIECE

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

Tests intended to be comparable shall be made on test pieces of substantially the same thickness.

To obtain the necessary thickness it is permissible to superimpose two pieces of rubber (but not more than two), provided these have flat parallel surfaces.

5.1 Normal test

The standard test piece shall be 8 to 10 mm thick; non-standard test pieces may be either thicker or thinner but not normally less than 4 mm. The lateral dimensions of both standard and non-standard test pieces shall be such that no test is made at a distance from the edge of the test piece less than the appropriate distance shown in table 2.

TABLE 2 – **Minimum distance of point of contact from test piece edge**

Total thickness of test piece	Minimum distance from point of contact to edge of test piece
mm	mm
4	7,0
6	8,0
8	9,0
10	10,0
15	11,5
25	13,0

6 TIME LAPSE BETWEEN VULCANIZATION AND TESTING

Unless otherwise specified for technical reasons the following requirements for time lapses shall be observed.

6.1 For all test purposes the minimum time between vulcanization and testing shall be 16 h. In cases of arbitration the minimum time shall be 72 h.

6.2 For non-product tests the maximum time between vulcanization and testing shall be 4 weeks and for evaluations intended to be comparable the tests, as far as possible, shall be carried out after the same time interval.

6.3 For product tests, whenever possible, the time between vulcanization and testing shall not exceed 3 months. In other cases tests shall be made within 2 months of the date of receipt by the purchaser of the product.

7 CONDITIONING OF TEST PIECES

7.1 When a test is made at a standard laboratory temperature, the test pieces shall be maintained at the conditions of test for at least 3 h immediately before testing.

7.2 When tests are made at higher or lower temperatures, the test pieces shall be maintained at the conditions of test for a period of time sufficient to reach temperature equilibrium with the testing environment, or for the period of time required by the specification covering the material or product being tested, and then immediately tested.

8 TEMPERATURE OF TEST

The test should normally be carried out in a standard atmosphere as specified in 3.2 of ISO/R 471, that is, 20 ± 2 °C, 23 ± 2 °C or 27 ± 2 °C. When other temperatures are used these shall be selected from the following list of preferred temperatures :

– 75, – 55, – 40, – 25, – 10, 0, 40, 50, 70, 85, 100, 125, 150, 175, 200, 225 and 250 °C.

The same temperature shall be used throughout any one test or series of tests intended to be comparable.

9 PROCEDURE

Condition the test piece as specified in clause 7. Lightly dust the upper and lower surfaces of the test piece with talcum powder. Place the test piece on a horizontal rigid surface. Bring the foot into contact with the surface of the test piece. Press the plunger and indenting ball for 5 s on to the rubber, the force on the ball being the contact force.

a) If the gauge is graduated in international rubber hardness degrees (IRHD), it shall be adjusted to read 100 at the end of the 5 s period; the additional indenting force shall then be applied and maintained for 30 s, when a direct reading of the hardness in international rubber hardness degrees is obtained.

b) If the gauge is graduated in metric units, the differential indentation D (in hundredths of a millimetre) of the plunger caused by the additional indenting force, applied for 30 s, shall be noted. This shall be converted into international rubber hardness degrees by using table 3 or a graph constructed therefrom.

During the loading periods the apparatus shall be gently vibrated unless it is completely free of friction.

10 NUMBER OF READINGS

One measurement shall be made at each of either three or five different points distributed over the test piece and the median of the results shall be taken, i.e. the middle value when these are arranged in increasing order.

11 EXPRESSION OF RESULTS

Hardness shall be reported to the nearest half IRHD as the median of the three or five measurements expressed in international rubber hardness degrees.

12 TEST REPORT

The test report shall include the following particulars :

a) the hardness expressed in IRHD;

b) the dimensions of the test piece, and whether made up of one or two pieces;

c) the temperature of test;

d) the type of surface tested, i.e. moulded, buffed or otherwise.

TABLE 3 – **Conversion of values of *D* to international rubber hardness degrees (IRHD)**

D = differential indentation, in hundredths of a millimetre, with 1 mm indentor

D	International rubber hardness degrees	*D*	International rubber hardness degrees	*D*	International rubber hardness degrees
0	100	15	97,3	30	91,1
1	100	16	97,0	31	90,7
2	100	17	96,6	32	90,2
3	99,9	18	96,2	33	89,7
4	99,9	19	95,8	34	89,3
5	99,8	20	95,4	35	88,8
6	99,6	21	95,0	36	88,4
7	99,5	22	94,6	37	87,9
8	99,3	23	94,2	38	87,5
9	99,1	24	93,8	39	87,0
10	98,8	25	93,4	40	86,6
11	98,6	26	92,9	41	86,1
12	98,3	27	92,5	42	85,7
13	98,0	28	92,0	43	85,3
14	97,6	29	91,6	44	84,8