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WITHDRAWN:

STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard Methods of Test for HOSE MADE FROM ELASTOMERIC MATERIALS

METHOD 9B. HARDNESS OF VULCANIZED RUBBERS OF LOW HARDNESS (10 TO 35 IRHD)

FOREWORD

The hardness test described herein is based on the measurement of the indentation of a rigid ball into the rubber test piece under specified conditions and is for use with rubbers in the lower end of the hardness scale, i.e. for rubbers of hardness of 10 to 35 international rubber hardness degrees (IRHD). For such rubbers it is desirable to decrease the indentation for a given hardness below that produced in the normal test so that the indentation produced in the softer rubbers is not excessive. For this purpose a larger indenter is used than that required for normal hardness with the same indenting force.

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, e.g. well-vulcanized 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 method 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 method AS 1180.9A.

NOTE: This method complements AS 1180. 9A, Hardness of Vulcanized Rubbers of Standard Hardness (35 to 85 IRHD). For rubbers of high hardness (85 to 100 IRHD) the method of AS 1180.9C applies.

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METHOD

1 **SCOPE.** This method describes a method of hardness testing for vulcanized rubbers with hardness in the range 85 to 100 IRHD.

The range of applicability of this and other hardness test methods for vulcanized rubbers (AS 1180.9A and 1180.9B) is indicated in Fig. 1.

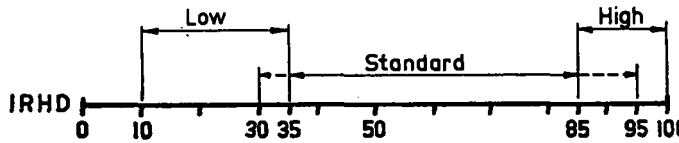

Fig. 1. RANGE OF APPLICABILITY OF HARDNESS TESTS

2 **PRINCIPLE.** The hardness test consists in measuring the difference between the depths of indentation of the ball into the rubber under 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 1, or a graph based on this table, or a scale, reading directly in international rubber hardness degrees and derived from the table, which is fitted to the indentation-measuring instrument.

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 megapascals, namely—

$$\frac{F}{M} = 0.0038\ R^{0.65}P^{1.35*}$$

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 Fig. 2. This curve is defined by—

(i) the value of $\log_{10}M$ corresponding to the midpoint of the curve
$= 0.364$ (M being expressed in MPa);

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

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

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TABLE 1

CONVERSION OF VALUES OF *D* TO INTERNATIONAL RUBBER HARDNESS DEGREES

D 0.01 mm	IRHD	*D* 0.01 mm	IRHD	*D* 0.01 mm	IRHD
110	34.9	180	21.3	250	14.1
2	34.4	2	21.1	2	14.0
4	33.9	4	20.8	4	13.8
6	33.4	6	20.6	6	13.7
8	32.9	8	20.3	8	13.5
120	32.4	190	20.1	260	13.4
2	31.9	2	19.8	2	13.3
4	31.4	4	19.6	4	13.1
6	30.9	6	19.4	6	13.0
8	30.4	8	19.2	8	12.8
130	30.0	200	18.9	270	12.7
2	29.6	2	18.7	2	12.6
4	29.2	4	18.5	4	12.5
6	28.8	6	18.3	6	12.3
8	28.4	8	18.0	8	12.2
140	28.0	210	17.8	280	12.1
2	27.6	2	17.6	2	12.0
4	27.2	4	17.4	4	11.8
6	26.8	6	17.2	6	11.7
8	26.4	8	17.0	8	11.6
150	26.1	220	16.8	290	11.5
2	25.7	2	16.6	2	11.4
4	25.4	4	16.4	4	11.3
6	25.0	6	16.2	6	11.2
8	24.7	8	16.0	8	11.1
160	24.4	230	15.8	300	11.0
2	24.1	2	15.6	2	10.9
4	23.8	4	15.4	4	10.8
6	23.5	6	15.3	6	10.6
8	23.1	8	15.1	8	10.5
170	22.8	240	14.9	310	10.4
2	22.5	2	14.8	2	10.3
4	22.2	4	14.6	4	10.2
6	21.9	6	14.4	6	10.1
8	21.6	8	14.3	8	10.0
				320	9.9

NOTE: D = differential indentation, with 5 mm indenter.

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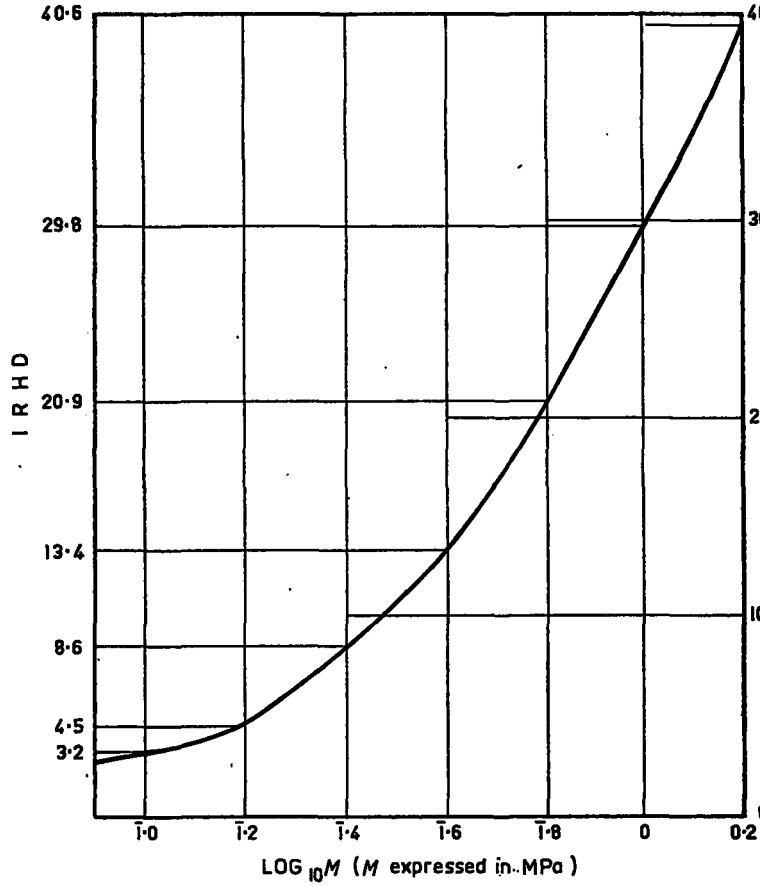

Fig. 2. RELATION OF LOG$_{10}M$ TO HARDNESS IN INTERNATIONAL RUBBER HARDNESS DEGREES

3 **BACKGROUND.** This method is technically identical with ISO/R1818—1971, Determination of Hardness of Vulcanized Rubbers of Low Hardness (10 to 35 IRHD).

4 **APPARATUS.** The essential parts of the apparatus are as follows, the appropriate dimensions and forces being shown in Table 2:

(a) *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 above the surface of the annular foot prior to applying the contact force.

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(b) *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 shall be as specified.

(c) *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 having a travel of 4 mm per revolution is suggested.

(d) *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 kPa, provided the total force on the foot does not fall outside the values given in Table 2. The foot should 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.

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

(f) *Chamber for the test piece,* when tests are made at temperatures other than a standard laboratory temperature. This chamber should be equipped with a means of maintaining the temperature within 2°C of the desired value. The foot and vertical plunger should extend through the top of the chamber, and the portion passing through the top should be constructed from a material having a low thermal conductivity. A sensing device should be located within the chamber, near or at the location of the test piece, for measuring the temperature.

TABLE 2

FORCES AND DIMENSIONS OF APPARATUS

Diameters mm	Force on ball			Force on foot N
	Contact N	Indenting N	Total N	
Ball 5.00 ± 0.01 Foot 22 ± 2 Hole 10 ± 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 2 will meet the pressure requirements for the flat annular foot.

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