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Indian Standard

METHODS OF TEST FOR VULCANIZED RUBBERS

PART XIII TENSION SET

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 1

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Indian Standard

METHODS OF TEST FOR VULCANIZED RUBBERS

PART XIII TENSION SET

0. FOREWORD

0.1 This Indian Standard (Part XIII) was adopted by the Indian Standards Institution on 10 November 1972, after the draft finalized by the Rubber Products Sectional Committee had been approved by the Chemical Division Council.

0.2 Tension set is an important property for the rubber components subjected to tensile stress intermittently.

0.3 The requirements for tension set in some of the present product specifications are based on different durations of time for application of strain and the formulae for calculations. The time and the formula specified in the product specifications shall be followed till they are revised to amend the value of tension set based on this test method.

0.4 This standard is mainly based on Draft ISO Recommendation No. 2285 Vulcanized rubbers — Determination of tension set under constant elongation at normal and high temperatures, issued by International Organization for Standardization.

0.5 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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1. SCOPE

1.1 This standard (Part XIII) prescribes the method for the determination of tension set under constant elongation of vulcanized natural and synthetic rubbers. This method is suitable for rubbers having the hardness within the range 30 to 94 International Rubber Hardness Degrees (IRHD).

*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definition shall apply.

2.1 Tension Set — Proportion of applied strain remaining after a test piece has been stretched and allowed to retract in a specified manner.

3. OUTLINE OF METHOD

3.1 Test piece of standard dimension is stretched to a specified length in a suitable apparatus for specified time and temperature and then allowed to recover. The tension set is then calculated as the percentage of the initial strain.

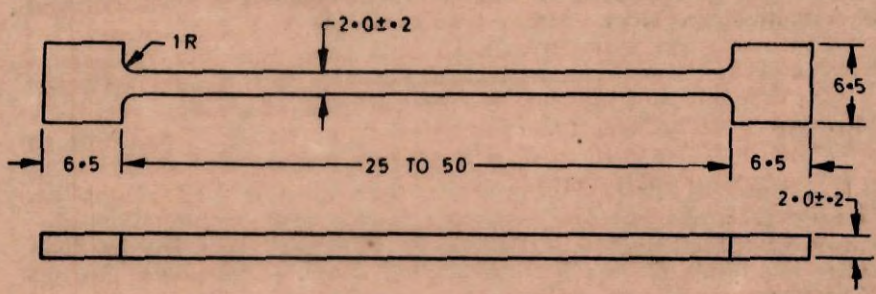
4. TEST PIECE

4.0 Three types of test pieces are described, strips, strips with enlarged ends and rings. Tests made with different types of test pieces do not necessarily give the same value of tension set.

4.1 Preparation

4.1.1 *Strip Test Piece* — Strips of the material under test between 2 and 10 mm in width and 2·0 ± 0·2 mm thick shall be cut with a sharp die from a flat sheet. A width of 6·0 mm is preferred. The sheets may be prepared by moulding or from finished articles by cutting and buffing. Strip test pieces may have, well outside the reference length, wider ends for easier clamping. The length of any given strip depends on the selected reference length and type of straining device.

4.1.2 *Strip Test Pieces with Enlarged Ends* — Test pieces of the shape shown in Fig. 1 shall be cut with a sharp die from a flat sheet, 2·0 ± 0·2 mm thick, of the material under test. The length of the narrow section (reference length) shall be between 25 and 50 mm. The sheets may be prepared by moulding or from finished articles by cutting and buffing.



All dimensions in millimetres.

FIG. 1 TEST PIECES WITH ENLARGED ENDS

4.1.3 *Ring Test Pieces* — Ring test pieces shall be cut from a flat sheet of the material under test, prepared by moulding or from finished articles by cutting and buffing, by means of a pair of concentric circular dies or rotating cutters. The separation of the two cutting edges or such dies or cutters shall not differ from the average value by more than 0·05 mm.

The following two sizes of ring test piece may be used:

Large ring test piece:

Thickness	4·0 ± 0·2 mm
Outer diameter	52·6 ± 0·2 mm
Inner diameter	44·6 ± 0·2 mm

Small ring test piece:

Thickness	2·0 ± 0·2 mm
Outer diameter	33·5 ± 0·2 mm
Inner diameter	29·5 ± 0·2 mm

4.2 Marking — A reference length shall be marked on the test pieces using a suitable bench marker and ink, which does not affect the material and withstand the temperature of test. The reference length for strip test pieces shall be between 25 and 50 mm. In the case of marking of ring test pieces, they shall be straightened by means of the rigid channel and the reference length, preferably 40 mm for large ring test pieces and 25 mm for small ring test pieces, marked on one of the straightened sides.

4.3 Number of Test Pieces — For each test, three test pieces shall be used.

4.4 Time Lapse Between Vulcanization and Testing

4.4.1 For all test purposes the minimum time between vulcanization and testing shall be 24 hours. 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, should be carried out after the same time interval. For product tests, whenever possible, the time between vulcanization and testing should not exceed 3 months. In other cases, tests should be made within two months of the date of receipt by the customer of the product.

4.4.2 Samples and test pieces shall be protected from light as completely as possible during the interval between vulcanization and testing.

4.5 Conditioning — Prepared test pieces shall be conditioned immediately before testing for a minimum period of 3 hours at 27 ± 2°C, the same temperature being used throughout the test.

5. APPARATUS

5.1 Straining Device — It consists of a metal rod or other suitable guide fitted with pairs of holders, one fixed and one movable, for the ends of the test piece. The holders shall be in the form of self-tightening clamps for strip test pieces, in the form of jaws to hold tap ends in a firm position for strip test pieces with enlarged ends and in the form of flat pulleys of about 5 mm width and 10 mm diameter for ring test pieces. If so desired, means of operating the moving holder other than by hand may be provided, for example, a screwed rod, provided that the tolerances on extension speed are met (*see* **6.1**). Suitable stops or graduations may also be provided, to avoid over-extension in the initial straining of the test piece.

5.2 Measuring Device — Suitable for measuring length to the nearest 0·1 mm.

5.2.1 For strip test pieces a bench marker shall be provided to mark the length used for measurement, hereinafter called the reference length.

5.2.2 For strip test pieces with enlarged ends the length of the narrow portion shall be used as the reference length.

5.2.3 For ring test pieces the reference length may alternatively be the inner diameter of the ring, in which case a graduated cone, allowing measurements to be made to the nearest 0·1 mm, may be used. If measurements are made on a straight reference length, a rigid channel, 3·5 mm deep and 20 mm wide for large ring test pieces, and 1·75 mm deep and 10 mm wide for small ring test pieces, shall be provided for straightening portions of such test pieces during marking and measuring of the reference length.

6. PROCEDURE

6.1 Measure the unstrained reference length to the nearest 0·1 mm at 27 ± 2°C. Place the ends of strip test pieces into the clamps, or tab ends of test pieces with enlarged ends into the jaws, or fit ring test pieces over the pulley rims of the straining device. Extend the test pieces to the required strain at a speed between 2 and 10 mm/s.

With ring test pieces, rotate the pulleys slightly by hand to equalize the strain in the two halves of the ring, ensuring that the reference length remains centralized between the pulleys.

6.2 Between 10 and 20 minutes after the specified strain has been reached, measure the strained reference length to the nearest 0·1 mm. When using the inner diameter of ring test pieces as the reference length, it may be calculated from the diameter of the pulleys and the distance between them, measured to the nearest 0·1 mm. If the strain, calculated as described in **7.1**, does not conform to the appropriate standard value, taking account of tolerances, the test pieces shall be discarded.

6.3 Tests at Elevated Temperatures

6.3.1 For tests at other than standard laboratory temperatures, place the strained test pieces into the oven operating at the test temperature. Between 20 and 30 minutes after the specified strain has been reached; at the end of the test period, remove the test pieces from the oven and allow to cool in the strained condition for 30 to 35 minutes.

6.3.2 Release the strain at a speed of 2 to 10 mm/s, remove the test pieces from the clamps or pulleys and lay free on a wooden surface. After $30 \begin{smallmatrix} +3 \\ -0 \end{smallmatrix}$ minutes measure the reference length to the nearest 0·1 mm, using the rigid channel to straighten ring test pieces, if required.

6.3.3 The common elevated temperatures at which this test may be carried out are 70 ± 1°C, 85 ± 1°C, 100 ± 1°C, 125 ± 2°C and 150 ± 2°C.

7. STRAIN AND DURATION OF TEST

7.1 Strain

7.1.1 *Calculation*

$$\text{Percentage strain} = 100\ \frac{l_s - l_o}{l_o}$$

where

l_o = original unstrained reference length, and

l_s = strained reference length, which shall be one of the following values:

percent
(25 ± 2·5)
(50 ± 5)
(100 ± 10)
(200 ± 10)
(300 ± 10)

7.1.2 The strain value should be selected in accordance with the final application of the vulcanizate and with reference to its breaking elongation and the test temperature. The value (100 ± 10) percent is preferred unless the above considerations dictate otherwise.

7.2 Duration of Test — The test pieces shall be strained for $24 \begin{smallmatrix} +0 \\ -2 \end{smallmatrix}$ hours or alternatively, if a longer test period is required, $72 \begin{smallmatrix} +0 \\ -2 \end{smallmatrix}$ hours or $168 \begin{smallmatrix} +0 \\ -2 \end{smallmatrix}$ hours the test period commencing 30 minutes after the original straining of the test pieces.

8. CALCULATION

8.1 Calculate the tension set as a percentage of initial strain:

$$\text{Tension set} = 100\ \frac{l_1 - l_0}{l_s - l_0}$$

where

l_1 = reference length after recovery,
l_0 = unstrained reference length, and
l_s = strained reference length.

8.1.1 The mean of the results for the three test pieces shall be calculated. The individual value for the three test pieces shall agree within 10 percent of the mean. If they do not, the test shall be repeated.

9. TEST REPORT

9.1 The test report shall include the following information:

a) Calculated mean value of tension set,
b) Type and dimensions of test piece,
c) Strain and temperature of test, and
d) Duration of test.

INDIAN STANDARDS

ON

RUBBER PRODUCTS

IS:

443-1963 Methods of sampling and test for rubber hoses (*revised*)

444-1968 Water hose of rubber with woven textile reinforcement (*second revision*) (*superseding* IS : 445-1964)

446-1968 Air hose of rubber with woven textile reinforcement (*second revision*) (*superseding* IS : 3557-1965)

447-1968 Welding hose of rubber with woven textile reinforcement (*second revision*)

635-1968 Oil and solvent resistant hose of rubber with woven textile reinforcement (*second revision*)

636-1962 Fire fighting hose (rubber lined woven jacketed) (*revised*)

637-1965 Rubber tubings for general purposes (*revised*)

638-1965 Sheet rubber jointing and insertion rubber jointings (*revised*)

911-1968 Air hose of rubber with braided textile reinforcement (*second revision*) (*superseding* IS : 912-1963)

913-1968 Water hose of rubber with braided textile reinforcement (*second revision*) (*superseding* IS : 914-1963)

1677-1968 Agricultural spray hose of rubber with braided textile reinforcement (*second revision*)

1685-1960 Whiting for rubber industry

1741-1960 Latex foam rubber products

1867-1961 Rubber hot water bottles

2396-1968 Rubber hose for petrol and diesel fuels with braided textile reinforcement (*first revision*)

2410-1963 Suction hose of rubber for fire services

2414-1969 Cycle tyres (*first revision*)

2415-1969 Cycle rubber tubes (*first revision*)

2482-1963 Water suction hose of rubber, light duty

2765-1964 Radiator hose

3418-1968 Oil and solvent resistant hose of rubber with braided textile reinforcement (*first revision*)

3549-1965 Water suction and discharge hose of rubber, heavy duty

3565-1966 Rubber teats for feeding bottles

3572-1968 Welding hose of rubber with braided textile reinforcement (*first revision*)

3692-1965 Rubber closures (pharmaceuticals)

3701-1966 Rubber protective sheaths (condoms)

3867-1966 Rubber ice bags

4135-1967 Hospital rubber sheeting

4148-1967 Surgical rubber gloves

4149-1967 Post-mortem rubber gloves

4770-1968 Rubber gloves for electrical purposes

5079-1969 Rubber valve tubing for cycle tube valves

5137-1969 Cement grouting hose of rubber with woven textile reinforcement

5166-1969 Cement grouting hose of rubber with braided textile reinforcement

5192-1969 Vulcanized rubber compounds

5193-1969 Rubber sealing rings for domestic fruit and vegetable preserving jars

5270-1969 Rubber grommets for general purposes

5382-1969 Rubber sealing rings for gas mains, water mains and sewers

5424-1969 Rubber mats for electrical purposes

5680-1969 Rubber tubing for medical use

5783-1970 Rubber ward-dressing and porters' gloves

5797-1970 Electrically bonded aircraft fuelling rubber hose

5821-1970 Hot water hose of rubber with woven textile reinforcement

5894-1970 Rubber sand blast hose with braided textile reinforcement

5937-1970 Hot water hose of rubber with braided textile reinforcement

6058-1970 Rubber components for transfusion fluid bottles

6407-1971 Rubber aprons for hospital use

6417-1971 Rubber sand blast hose with woven textile reinforcement

6450-1971 Rubbers for the dairy industry