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Indian Standard

METHODS OF TEST FOR VULCANIZED RUBBERS

PART X COMPRESSION SET AT CONSTANT STRAIN

(First Revision)

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Indian Standard

METHODS OF TEST FOR VULCANIZED RUBBERS

PART X COMPRESSION SET AT CONSTANT STRAIN

(*First Revision*)

0. FOREWORD

0.1 This Indian Standard (Part X) (First Revision) was adopted by the Indian Standards Institution on 17 October 1977, after the draft finalized by the Rubber Products Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

0.2 This standard was first published in 1969 and has been mainly revised to include sets of temperatures and durations of test which are included in ISO 815-1972 'Vulcanized rubbers — Determination of compression set under constant deflection at normal and high temperatures', published by the International Organization for Standardization.

0.3 This test method for determining the compression set characteristics of vulcanized rubbers is intended to measure the ability of rubber of hardness within the range 30 to 95 IRHD*, to retain their elastic properties after prolonged compression at constant strain.

0.4 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 X) prescribes a method of test for determining the compression set characteristics of vulcanized rubbers of hardness within the range of 30 to 95 IRHD*, at constant strain under one of the alternative sets of conditions prescribed (*see* **6.1** and **6.2**). With some rubbers, especially those above 95 IRHD*, it may not be possible to achieve 25 percent compression strain. For such rubbers this method does not apply.

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*International rubber hardness degrees.

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

2. TERMINOLOGY

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

2.1 Compression Stress — Stress applied so as to cause contraction of the test piece in the direction of stress.

2.2 Compression Strain — The proportionate contraction produced in the test piece by compression stress.

2.3 Compression Set at Constant Strain — The difference between the original thickness of the test piece and that after recovery, expressed as a percentage of the initially applied compression.

3. OUTLINE OF THE METHOD

3.1 A test piece in the shape of a cylindrical disk is subjected to a constant strain under compression in a compression device for a given time at the specified temperature, and then it is allowed to recover for a given time. The difference between original thickness and thickness after recovery is expressed as a percentage of initially applied compression.

4. APPARATUS

4.1 Compression Apparatus — The compression apparatus consists of two or more parallel, flat, highly polished chromium plated steel or highly polished stainless steel plates between the faces of which the test pieces are compressed; these plates are sufficiently rigid to withstand the stress without bending, and of sufficient size to ensure that all the compressed test pieces are within the area of the plates. The plates are held together by a bolt or bolts of suitable size. Steel spacers, preferably in the form of rings, are used to provide for the recommended compression. The spacers are of such a size that contact with the compressed test pieces is avoided.

4.2 Oven — Any well designed, uniformly heated air-oven, capable of maintaining the compression apparatus and test pieces within ±1 deg of the temperature of test specified in **6.2**. Normally provision shall be made for a slow circulation of air through oven. Air flow shall be such that not less than three nor more than ten changes per hour shall take place.

4.3 Thickness Gauge — A dial micrometer gauge preferably having a raised platform 9·5 mm in diameter and a spherical presser foot 6·35 mm in diameter or alternately having two contact members of domed surfaces with spherical radius of 12·5 mm formed on rods of 10 mm diameter. The guage should operate on a dead-weight load of 0·85 ± 0·03 N (85 ± 3 g) and shall have a scale graduated in unit divisions of 0·01 mm.

5. TEST PIECES

5.1 Large Type — A cylindrical disk of diameter 29·0 ± 0·5 mm and thickness 12·5 ± 0·5 mm, prepared either by moulding or by cutting. Cutting is done by means of a sharp rotating circular die or circular knife, lubricated with soapy water, and brought carefully into contact with the rubber which is preferably mounted on wood or other suitable backing material, the cutting pressure being kept sufficiently small to avoid 'cupping' of the cut surface.

5.2 Small Type — A cylindrical disk of diameter 13·0 ± 0·5 mm and thickness 6·3 ± 0·3 mm prepared as described in **5.1**.

5.3 Laminated Type — Test pieces conforming to large type (**5.1**) or small type (**5.2**) may be prepared by laminating disks of rubber cut out from sheets provided the number of disks laminated does not exceed 7 for large type and 3 for small type.

NOTE 1 — Two sizes of test pieces described do not necessarily give the same values of compression set and comparison of values obtained from the two sizes should be avoided. Unless specified otherwise in the material specification large size test piece shall be used.

NOTE 2 — The preparation of test pieces by either moulding or by cutting is permitted. For some types of rubber, test pieces prepared by different methods may give different results. Where possible, the preparation of test pieces by moulding is recommended.

NOTE 3 — Laminated test pieces made up of two or more superimposed disks may also be used. These do not generally give the same values of compression set as test pieces of the same dimensions formed of one disk.

6. DURATION AND TEMPERATURE OF TEST

6.1 Duration of Test — The time shall be 24^{+0}_{-2}, 72^{+0}_{-2} or 168^{+0}_{-2} hours.

6.2 Temperature of Test — The temperature of test shall be one of the following:

Standard Laboratory Temperature (27 ± 1°C)
70 ± 1°C
85 ± 1°C
100 ± 1°C
125 ± 2°C
150 ± 2°C
175 ± 2°C
200 ± 2°C
225 ± 2°C
250 ± 2°C

7. PROCEDURE

7.1 Number of Tests — Test three test pieces.

7.2 Conditioning of Test Pieces — The test piece shall be conditioned at the standard laboratory temperature of 27 ± 1°C for not less than 3 hours immediately before testing.

NOTE 1 — The properties of vulcanized rubbers change continuously with time, these changes being particularly rapid during the first 24 hours after vulcanization. Therefore, no test should be carried out within this period. For accurate comparison between different rubbers, it may be necessary to ensure that these are tested at almost the same interval after vulcanization. For products the maximum interval should be 3 months where the date of vulcanization is known. If this is not known it should be six weeks from the date of receipt by the consumer, unless otherwise specified.

NOTE 2 — Samples and test pieces shall be protected from light as completely as as possible during the interval between vulcanization and testing.

7.3 Measure the thickness of each test piece at the central portion of the test piece. Place one large or three small test pieces symmetrically between each pair of plates together with the requisite spacer(s). Tighten the bolt or bolts so that the plates are drawn together uniformly until they are in contact with the spacer(s). The applied compression should be approximately 25 percent of the original thickness of the test piece so that the appropriate heights of spacer for large and small test pieces are 9·40 ± 0·01 mm and 4·70 ± 0·01 mm respectively. Introduce the compression apparatus containing the test pieces without delay into the central part of an oven which is operating at the test temperature (**6.2**). Upon completion of the required time of test, remove the compression apparatus from the oven; loosen the bolts, and transfer the test pieces quickly to a wooden bench. Allow them to recover on the wooden bench at 27 ± 2°C for 30 to 33 minutes. Measure the thickness again.

7.3.1 Cut the test piece that has been used for the test into two along the diameter and examine for any internal defect, such as the presence of air bubbles. If any porosity or defects are found then discard the results.

NOTE — The clamp is maintained at 27 ± 2°C and its operating surfaces are carefully cleaned before use.

8. CALCULATION

8.1 Calculate the compression set expressed as a percentage of the initial deflection from the following formula:

$$\text{Compression set, percent} = \frac{t_0 - t_1}{t_0 - t_s} \times 100$$

where

t_0 = initial thickness in mm of the test piece,

t_1 = thickness of the test piece in mm after recovery, and

t_s = height of the spacer in mm.

8.1.1 The results for the three test pieces shall agree within 5 percent of the mean compression set value; if they do not, the test shall be repeated.

9. REPORT

9.1 The report shall include the following:

a) The duration and temperature of test;

b) The type of test piece (large, small or laminated);

c) The nature of the test piece (moulded or cut);

d) Initial thickness of the test piece t_0;

e) The thickness of the test piece after recovery t_1; and

f) The mean value of compression set values.

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