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Rubber, vulcanized or thermoplastic — Determination of compression set at ambient, elevated or low temperatures

*Caoutchouc vulcanisé ou thermoplastique — Détermination de la
déformation rémanente après compression aux températures ambiantes,
élevées ou basses*



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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.

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.

International Standard ISO 815 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Sub-Committee SC 2, *Physical and degradation tests*.

This second edition cancels and replaces the first edition (ISO 815:1972) and the first edition of ISO 1653 (ISO 1653:1975), of which it constitutes a technical revision.

Annexes A and B of this International Standard are for information only.

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Rubber, vulcanized or thermoplastic — Determination of compression set at ambient, elevated or low temperatures

1 Scope

This International Standard specifies methods for the determination of compression set characteristics of vulcanized and thermoplastic rubbers at ambient, elevated or low temperatures.

The methods are intended to measure the ability of rubbers of hardness within the range 10 IRHD to 95 IRHD to retain their elastic properties at specified temperatures after prolonged compression at constant strain (where possible 25 %) under one of the alternative sets of conditions described. For rubber of hardness greater than 80 IRHD, a lower compression strain is used: 15 % for a nominal hardness from 80 IRHD to 89 IRHD and 10 % for a nominal hardness from 90 IRHD to 95 IRHD.

NOTES

1 When rubber is held under compression, physical or chemical changes can occur that prevent the rubber returning to its original dimensions after release of the deforming force. The result is a set the magnitude of which depends on the time and temperature of compression as well as on the time and temperature of recovery. At elevated temperatures, chemical changes become increasingly more important and lead to a permanent set which can be measured by allowing test pieces to recover at standard temperature. At low temperatures, changes resulting from the effects of glass hardening or crystallization become predominant, and since these effects are reversed by raising the temperature it is necessary for all measurements to be undertaken at the test temperature (see ISO 6471).

2 Guidance for using the precision results is given in informative annex A, and results for compression set at -25°C and 100°C without lubricant in informative annex B.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All stan-

dards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 468:1982, *Surface roughness — Parameters, their values and general rules for specifying requirements*.

ISO 471:1983, *Rubber — Standard temperatures, humidities and times for the conditioning and testing of test pieces*.

ISO 1826:1981, *Rubber, vulcanized — Time-interval between vulcanization and testing — Specification*.

ISO 3383:1985, *Rubber — General directions for achieving elevated or subnormal temperatures for test purposes*.

ISO 4648:1991, *Rubber, vulcanized or thermoplastic — Determination of dimensions of test pieces and products for test purposes*.

ISO 4661-1:1986, *Rubber, vulcanized — Preparation of samples and test pieces — Part 1: Physical tests*.

ISO 6471:1983, *Rubber, vulcanized — Determination of crystallization effects under compression*.

ISO/TR 9272:1986, *Rubber and rubber products — Determination of precision for test method standards*.

3 Principle

3.1 Ambient and elevated temperatures

A test piece of known thickness is compressed at standard temperature to a defined strain, which is then maintained constant for a specified time at a fixed standard or elevated temperature. The strain

is released and, after the test piece has been allowed to recover at standard temperature for a specified time, the thickness of the test piece is again measured.

3.2 Low temperatures

A test piece of known thickness is compressed at standard temperature to a defined strain, which is then maintained constant for a specified time at a fixed low temperature. The strain is released and the test piece allowed to recover at this temperature. The thickness is measured at intervals after the release of the strain so that an assessment of compression set characteristics is obtained from a plot of recovery against time at the low temperature.

4 Apparatus

4.1 Compression apparatus, consisting of compression plates, steel spacers and clamping device.

4.1.1 Compression plates, comprising a pair of parallel, flat, highly polished chromium-plate steel or highly polished stainless-steel plates, between the faces of which the test piece is compressed.

The finish of the surface of the compression plates shall be not worse than $0,4 \mu\text{m } R_a$ from the mean line of the profile (see ISO 468). The plates shall

- be sufficiently rigid to ensure that, with a test piece under load, no compression plate shall bend by more than 0,01 mm;
- be of sufficient size to ensure that the whole of the test piece, when compressed between the plates, remains within the area of the plates.

Steel plates with a diameter of approximately 115 mm and with a thickness of 6,5 mm and 12,5 mm, respectively, are suggested. A typical apparatus is shown in figure 1.

4.1.2 Temperature measurement device.

For low-temperature tests, the plates shall incorporate means of measuring their temperature directly with an accuracy of $\pm 0,5^\circ\text{C}$.

4.1.3 Mild-steel spacer(s), to provide the required compression. The spacer(s) shall be of such size and shape that contact with the compressed test piece is avoided.

The height of the spacer(s) shall be as follows: where more than one spacer is used in any one test,

the heights shall match to within $\pm 0,01$ mm of the mean.

Spacer dimensions	Test piece type
9,4 mm max.	A
9,3 mm min.	
4,8 mm max.	B
4,7 mm min.	

When crystallization studies are to be made, it is necessary to control the compression strain as accurately as possible, and spacers of different heights are required. The height of the spacers shall be chosen so that the compression of the test piece is $(25 \pm 1) \%$ of the measured thickness of the test piece.

A compression strain of 15 % shall be used for hardnesses between 80 IRHD and 89 IRHD. The height of the spacer(s) shall be as follows:

Spacer dimensions	Test piece type
10,7 mm max.	A
10,6 mm min.	
5,4 mm max.	B
5,3 mm min.	

A compression strain of 10 % shall be used for hardnesses above 90 IRHD. The height of the spacer(s) shall be as follows:

Spacer dimensions	Test piece type
11,30 mm max.	A
11,25 mm min.	
5,70 mm max.	B
5,65 mm min.	

NOTE 3 For crystallization studies, in order to achieve the accuracy of compression needed to meet the permitted tolerances on test piece height, three sets of spacers for type A and four sets of spacers for type B are required. For instance, spacers of heights 9,12 mm, 9,38 mm and 9,62 mm for type A and spacers of heights 4,56 mm, 4,67 mm, 4,78 mm and 4,89 mm for type B, all to a tolerance of $\pm 0,005$ mm, would cover the range adequately.

Where a range of spacers is not available, the use of slip gauges is recommended to obtain the correct compressed height. Care shall be taken that, with the test piece in its compressed state, the compression plates are parallel.

Dimensions in millimetres

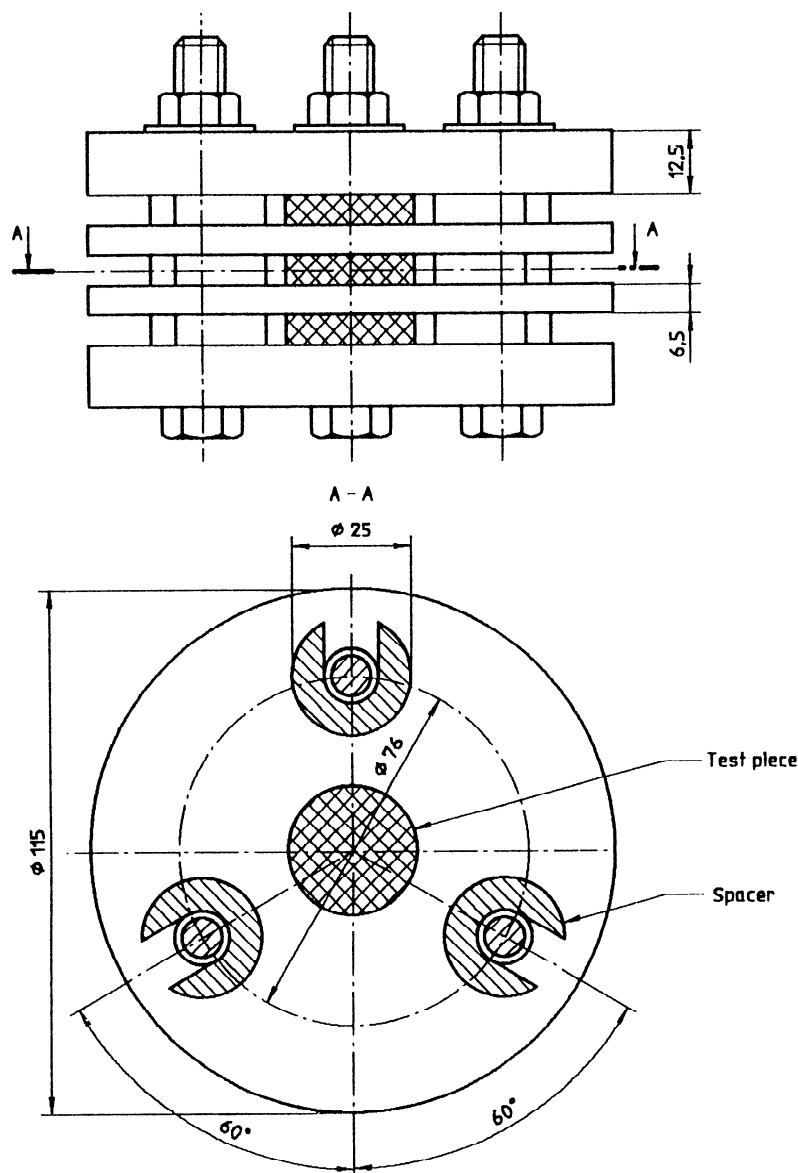


Figure 1 — Typical apparatus for the determination of compression set using type A test pieces

4.1.4 Clamping device.

For testing at standard or elevated temperatures, a simple screw device is adequate. For testing at low temperatures, a quick-release device is required. This may be either mechanical or pneumatic.

4.2 Oven or low-temperature cabinet, complying with the requirements specified in ISO 3383, and capable of maintaining the compression apparatus and test pieces at the test temperature within the tolerance specified in 6.2.

The low-temperature cabinet may be mechanically refrigerated or may be cooled directly by dry ice or liquid nitrogen. The test temperature shall be

measured directly in the plates of the compression apparatus with an accuracy of $\pm 0,5^{\circ}\text{C}$.

The cabinet for low-temperature testing shall be equipped so that it is possible to release the test pieces and carry out subsequent measurements without direct contact, e.g. by use of hand-holes and gloves or a remote-handling device. The cabinet shall be capable of maintaining its temperature within the permissible variation while these operations are being carried out.

The time to reach a steady-state temperature depends on the type of oven or cabinet and the heat content of all the compression apparatus. To obtain comparable results in the case of an elevated test temperature and a 24 h duration of test, it is necessary to reach the steady-state temperature