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**Rubber, vulcanized or thermoplastics —
Determination of stress relaxation**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Rubber Manufacturers Association (JRMA)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS K 6263** : 2015), which has been technically revised.

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Rubber, vulcanized or thermoplastics — Determination of stress relaxation

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 3384-1** : 2019, Edition 2, with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies procedures for determining the decrease in counterforce exerted by vulcanized or thermoplastic rubber which has been subjected to the specified compression or tensile deformation and maintained in the specified environment (not less than the standard laboratory temperature). Testing at temperatures below standard laboratory temperature can be conducted; however, the reliability of the results is not proven.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 3384-1 : 2019 *Rubber, vulcanized or thermoplastic — Determination of stress relaxation in compression — Part 1: Testing at constant temperature* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

WARNING 1 Persons using this Standard should be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this Standard to establish appropriate safety and health practices.

WARNING 2 Certain procedures specified in this Standard might involve the use or generation of substances, or the generation of waste, that could constitute a local environmental hazard. Reference should be made to appropriate laws/regulations on safe handling and disposal after use.

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the

editions of the indicated year shall be applied and the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent editions (including amendments) shall be applied.

JIS B 2401-1 *O-rings — Part 1 : O-rings*

NOTE Normative reference in the corresponding International Standard : ISO 3601-1 *Fluid power systems — O-rings — Part 1 : Inside diameters, cross-sections, tolerances and designation codes*

JIS K 6200 *Rubber — Vocabulary*

JIS K 6250 : 2019 *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

NOTE Normative reference in the corresponding International Standard : ISO 23529 *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

JIS K 6254 : 2016 *Rubber, vulcanized or thermoplastic — Determination of stress-strain properties*

NOTE Normative reference in the corresponding International Standard : ISO 7743 *Rubber, vulcanized or thermoplastic — Determination of compression stress-strain properties*

JIS K 6257 : 2017 *Rubber, vulcanized or thermoplastic — Determination of heat ageing properties*

NOTE Normative reference in the corresponding International Standard : ISO 188 *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

JIS K 6258 : 2016 *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

NOTE Normative reference in the corresponding International Standard : ISO 1817 *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

JIS K 6272 : 2003 *Rubber — Tensile, flexural and compression test equipment (constant rate of traverse) — Specification*

JIS Z 8401 *Rounding of numbers*

ISO 18899 : 2013 *Rubber — Guide to the calibration of test equipment*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions, and those given in **JIS K 6200** apply.

3.1

compression stress relaxation

reduction in compressive force, expressed as a percentage of the initial force, which occurs under the specified conditions

3.2

tensile stress relaxation

reduction in tensile force, expressed as a percentage of the initial force, which occurs under the specified conditions

3.3

test strain

ratio of change in compression or tensile deformation to test piece during test

Note 1 to entry For the compression stress relaxation test, it is calculated from the distance between the compression plates.

Note 2 to entry For the tensile stress relaxation test, it is calculated from the distance between the grips.

4 Classification of tests

Tests are classified into the following two types :

- a) Compression stress relaxation test;
- b) Tensile stress relaxation test.

5 Compression stress relaxation tests

5.1 Principle

A cylindrical or ring test piece is compressed to a constant deformation and maintained at a predetermined temperature and time. The decrease in counterforce is then measured to obtain the characteristics of compression stress relaxation.

The compression stress relaxation tests are classified into the following two methods. These tests can be conducted in a gaseous or a liquid environment.

- a) **Method A** The compression is applied and all counterforce measurements are made at a test temperature.
- b) **Method B** The compression is applied and all counterforce measurements are made at a standard laboratory temperature. In the case other than counterforce measurements, the test pieces are stored at the test temperature.

The two measurement methods, A and B, do not give the same values of stress relaxation, and comparison of values obtained from the two methods should be avoided. In Method B, the shrinkage of the material from the test temperature to standard laboratory temperature is included in the result. The method selected for use depends on the purpose of the test. Thus, for fundamental studies and in applications where sealing at elevated temperatures is a problem, Method A might be preferred, and in applications where temperature cycling from normal to an elevated temperature is a problem, Method B might be preferred.

NOTE Other methods can be used for specific purposes, such as applying the compression at standard laboratory temperature and making all coun-

terforce measurements at a different temperature.

5.2 Apparatus

The apparatus is composed of compression device, counterforce-measuring device, oven and bath, and temperature-measuring equipment, and each device shall be as follows.

5.2.1 Compression device, consisting of two parallel, flat, highly polished plates made of chromium-plated steel or stainless-steel or any corrosion-resistant material, between the faces of which the test piece is compressed. Flatness, parallelism and rigidity of the plates are all important due to their influences on the test results.

The compression device shall satisfy the following conditions.

- When a test piece between plates is under load in the assembly of the compression device, the plates shall be sufficiently rigid to ensure that no compression plate bends by 0.01 mm or more.
- The plates shall 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 and can expand freely laterally.

NOTE 1 A surface roughness, measured in accordance with **JIS B 0601**, of not worse than Ra 0.4 μm has been found to be suitable. Such an Ra can be obtained by a grinding or polishing operation.

Ra is the arithmetic average roughness calculated from the surface profile measured by the contact (stylus) instrument.

- When the apparatus is assembled without a test piece, the gap between the plates shall not vary by ± 0.01 mm or more for a system measuring the counterforce at prescribed time intervals (discontinuous jigs) and by ± 0.1 mm or more for a continuous-measurement system (continuous rigs).

NOTE 2 The parallelism is not as critical for continuous rigs as they are only compressed once.

- For ring test pieces, the plates shall have holes of at least 2 mm diameter drilled through their centre portions to allow equalization of pressure and circulation of fluid inside the ring-shaped test piece.
- It shall be possible to connect the compression device to suitable equipment for compressing the test piece to the specified compression at the specified speed and for measuring the counterforce exerted by the compressed test piece with an accuracy of 1 % of the measured value.
- The device shall be capable of setting the compression and maintaining it during the whole duration of the test, and it shall be possible to keep the device in an oven at the specified test temperature. Care shall be taken to ensure that there is no loss of heat from the test piece, for example by conduction through metal parts

which are connected with the outside of the oven.

5.2.2 Counterforce-measuring device, capable of measuring compression forces in the desired range with an accuracy of 1 % of the measured value.

The counterforce-measuring device shall be in accordance with either **a)** or **b)**.

- a) The device may be a continuous-measurement system which monitors the test piece during the whole duration of the test, making it possible to measure the change in the counterforce with time on a continuous basis. The deformation of the test piece shall be kept within ± 0.01 mm for the duration of the test. If it is not possible to keep the test strain within this tolerance due to the spring effect in load cells, a correction may be done mechanically or mathematically.

This procedure is mostly used for testing according to Method A, but can be used for Method B using a temperature cycling oven.

- b) Alternatively, a compression-testing machine may be used to measure the counterforce at prescribed time intervals. In this case, the force necessary to cause a slight increase in the compression of the test piece is measured. This additional compression shall be as small as possible and in no case greater than a force of 1 N for balance-type machines, or greater than 0.05 mm for stress/strain-type machines, applied in either case without overshoot.

The whole of the force exerted by the test piece as a result of the extra compression shall act on the force-measuring device. It shall also be possible to repeat the compression to within ± 0.01 mm from one measurement to another.

This procedure is mostly used for testing according to Method B, but can be used for Method A using an oven during the measurements.

5.2.3 Oven and bath, as follows.

- a) **Oven**, in accordance with the requirements of Clause 4 of **JIS K 6257 : 2017**.

If the testing is done in nitrogen, oxidative ageing will be eliminated and the result will be due to thermal ageing only. This can be used to simulate conditions where the product is not exposed to air, such as seals used in oil or steam.

- b) **Bath** For tests in liquids, the compression device shall be totally immersed in a liquid in a bath, or a closed vessel for volatile or toxic fluids. The liquid shall be maintained at the specified temperature by proper control of a heater and circulation of the liquid in the bath or, alternatively, by placing the liquid bath and compression device within an oven as specified in **a)**.

5.2.4 Temperature-measuring equipment, with a sensing element of appropriate precision. The temperature-sensing element shall be fitted in such a way that it accurately measures the temperature of the test piece.

NOTE A Pt100 (platinum resistance thermometer) sensor has been found to be suitable for temperature measurement.

5.3 Calibration