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Rubber, vulcanized — Determination of stress in tension upon heating

Caoutchouc vulcanisé — Détermination de la contrainte en traction lors du chauffage

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This second edition cancels and replaces the first edition (ISO 12493:2011), of which it constitutes a minor revision to update the normative references in Clause 2.

Introduction

Vulcanized rubber held under a constant stress will contract as the test temperature is raised, while a test piece held under a constant strain will develop an increased stress. These are features of the Gough-Joule effect in rubber and, unless they are taken into account at the design stage, any resulting changes in forces and dimensions can affect the performance of some products, such as rotary seals, used at high temperatures and high strains (see Reference [1]).

This document describes a test method for the determination of the change in tensile stress that results from an increase in test temperature.

Rubber, vulcanized — Determination of stress in tension upon heating

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

WARNING 2 — Certain procedures specified in this document 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 documentation on safe handling and disposal after use.

1 Scope

This document specifies a method for measuring the stress in tension which is developed in vulcanized rubber when it is heated (thermal stress). The thermal stress is measured for various pre-strain and temperature conditions as a function of time.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

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

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
thermal stress
σ_T
force per initial unit area which is developed in the test piece upon heating

Note 1 to entry: It is expressed in N/m^2 or Pa.

3.2
maximum thermal stress
max. σ_T
peak value of the thermal stress recorded during the test

3.3
thermal stress after a specified time
$\sigma_{T,t}$
stress induced in the test piece upon heating for a specified time t

3.4
pre-strain
elongation to which the test piece is subjected at the beginning of the test

Note 1 to entry: It is expressed as:

$$\text{pre-strain} = \frac{l_f - l_i}{l_i}$$

where

l_i is the initial length;

l_f is the length after elongation.

3.5
pre-stress
force per initial unit area which results from the pre-strain

Note 1 to entry: It is expressed in N/m^2 or Pa.

4 Principle

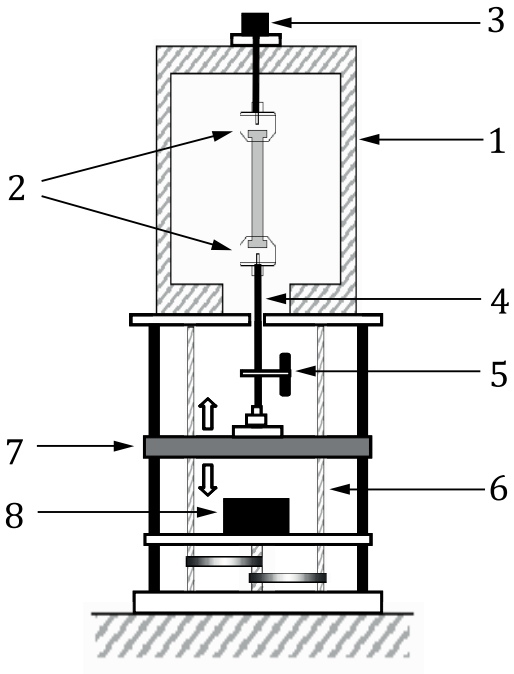
A test piece is held at a constant pre-strain in a tensile mode at standard laboratory temperature. When the pre-stress resulting from the given pre-strain has reached an apparent equilibrium value, the temperature of the test piece is increased. The thermal stress developed at the elevated temperature is measured for various pre-strain conditions as a function of time.

5 Apparatus

5.1 Thermal-stress testing machine

An example of a test machine for measuring the thermal stress developed in rubbery materials when heated is shown in Figure 1. Two clamps hold the test piece in a temperature-controlled chamber, with the upper clamp connected to a load cell and the bottom clamp connected to a crosshead. The crosshead is moved using a screw driven by a motor to impose a pre-strain on the test piece. The thermal stress developed when the temperature is raised is transmitted to the load cell and the output is recorded to give the variation in stress as a function of time.

The test machine shall comply with ISO 5893 with force measurement to class 1 and the machine shall be capable of setting the pre-strain to within ± 0,1 at a speed of (20 ± 2,5) mm/min.



Key

1 temperature-controlled chamber
2 clamps
3 load cell
4 rod
5 linear variable differential transformer
6 screw
7 crosshead
8 motor

Figure 1 — Example of thermal-stress testing machine

5.2 Temperature-controlled chamber

The temperature-controlled chamber shall be capable of raising the temperature at a rate of at least 30 °C/min and maintaining the test piece at the required temperature as specified in ISO 23529. A suitable volume for the chamber is 3 l to 5 l. A temperature-sensing device shall be located within the chamber near the test piece.

5.3 Thickness- and width-measuring devices

Instruments for measuring the thickness and width of the test piece shall be in accordance with ISO 23529.

6 Calibration

The test apparatus shall be calibrated in accordance with the schedule given in Annex A.