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GB/T 1685.2-2019

Rubber, vulcanized or thermoplastic - Determination of stress relaxation in compression - Part 2: Testing with temperature cycling

硫化橡胶或热塑性橡胶 压缩应力松弛的测定 第2部分：循环温度下试验

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Foreword

GB/T 1685 "Rubber, vulcanized or thermoplastic - Determination of stress relaxation in compression" is proposed to include the following two parts:

- Part 1: Testing at constant temperature;

- Part 2: Testing with temperature cycling.

This Part was drafted in accordance with the rules given in GB/T 1.1-2009.

This Part adopts ISO 3384-2:2012 "Rubber, vulcanized or thermoplastic - Determination of stress relaxation in compression - Part 2: Testing with temperature cycling", by translation.

The Chinese documents corresponding to the international documents normatively referenced in this Part are as follows:

This Part was proposed by the China Petroleum and Chemical Industry Federation.

This Part shall be under the jurisdiction of the National Technical Committee on Rubber and Rubber Products of Standardization Administration of China (SAC/TC 35).

Drafting organizations for this Part: Northwest Rubber & Plastics Research & Design Institute Co., Ltd.; Guangzhou Synthetic Materials Research Institute Co., Ltd.; Double Star Group Co., Ltd.; Gotwell Scientific Instruments (Qingdao) Co., Ltd.; Qingdao Junxiang Technology Co., Ltd.; Triangle Tyre Co., Ltd.; Shanghai Zhenjun Chemical Technology Co., Ltd.; Jiangsu Mingzhu Testing Machinery Co., Ltd.; Shanghai Hanhai Testing Technology Co., Ltd.; Beijing Zhongtian Pengyu Technology Development Co., Ltd.; Qingdao University of Science and Technology; Beijing Rubber Industry Research & Design Institute Co., Ltd.

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Introduction

When a constant strain is applied to rubber, the force required to maintain that strain is not constant but decreases over time; this phenomenon is known as "stress relaxation". Conversely, when rubber is subjected to a constant stress, the strain increases over time; this phenomenon is known as "creep".

In essence, stress relaxation is primarily caused by physical and chemical processes. While these two processes often occur simultaneously, stress relaxation is predominantly caused by physical processes at ambient or low temperatures and/or over short durations, whereas it is predominantly caused by chemical processes at high temperatures and/or over long durations.

When it is necessary to investigate the service life of a material, testing may be conducted using the method described in GB/T 20028 "Rubber, vulcanized or thermoplastic - Estimation of life-time and maximum temperature of use from an Arrhenius plot".

Stress relaxation tests require the specification of not only the test temperature and time intervals but also the initial stress and the loading conditions of the specimen, as these factors influence the test results, particularly for rubbers containing fillers.

The two cyclic test methods specified are designed for the following purposes:

measure its sealing force at low temperature.

For rubber products used outdoors, the ambient temperature may cycle between high temperatures (e.g., 150 °C) and low temperatures (e.g., -40 °C). When evaluating the practical performance and service life of such products, it is crucial to consider their shrinkage behavior at low temperatures.

Rubber undergoes crystallization at low temperatures, which further intensifies the degree of shrinkage. For example, rubber hoses and seal rings used in automobiles may function well at ambient temperatures, but could leak at low temperatures.

1 Scope

This Part of GB/T 1685 specifies two methods for determining the decrease in compressive force of vulcanized or thermoplastic rubber, that has been compressed to and maintained at a constant strain, under temperature cycling conditions.

Method A: The test temperature alternates between high and low temperatures at set intervals; the rubber material's aging resistance is evaluated at the high-temperature phase, while its sealing performance is evaluated at the low-temperature phase.

Method B: The test temperature alternates continuously between high and low temperatures, to induce internal thermal stress within the rubber material.

The compressive force is measured, using a continuous monitoring system.

Specimens may be cylindrical or annular (ring-shaped). Results vary depending on the different shape and size of the specimens; test results are comparable only when obtained from specimens of the same shape and size.

Annular specimens are particularly suitable for determining stress relaxation in liquid environments.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

3 Terms and definitions

The following terms and definitions apply to this document.

The phenomenon where the compressive force decreases over time following the application of a constant compressive deformation, which is expressed as the percentage reduction of the compressive force relative to its initial value.

Stress generated within an object during a temperature change, when external constraints or mutual constraints between internal parts prevent it from expanding or contracting completely freely.

4 Principle

A specimen of vulcanized or thermoplastic rubber is compressed to and maintained at a constant strain; the reduction in compressive force is measured.

The test temperature is cycled between specified high and low temperatures, to evaluate the sealing force of the rubber material at low temperatures. As the rubber material transitions from high to low temperature, it contracts, causing a reduction in compressive force.

5 Instruments

5.1 Compression device

Consists of two parallel, flat, highly polished plates. The plates are made of chromiumplated material, stainless steel, or other corrosion-resistant material; the specimen is compressed between the two plates. Plate flatness, surface finish, parallelism, rigidity are critical. The surfaces of the compression plates shall be ground and polished. The compression plates shall be flat and parallel; they shall not undergo any deformation when the test load is applied. Note: A suitable surface roughness (Ra) of not more than 0.4 µm (see ISO 4287) can be achieved, by grinding or polishing the surfaces of the compression plates. When the compression device is assembled without a specimen, the gap between the two compression plates shall remain within ±0.01 mm. When the specimen is installed and the load is applied, neither compression plate shall deflect by more than 0.01 mm. The compression plates shall be of sufficient size, to ensure that the entire specimen lies within the compression area of the plates and can expand laterally without restriction. For annular specimens, a through-hole with a diameter of at least 2 mm shall be provided at the center of the compression plates, to allow for pressure equalization