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Rubber, vulcanized or thermoplastic — Estimation of life-time and maximum temperature of use

Caoutchouc vulcanisé ou thermoplastique — Estimation de la durée de vie et de la température maximale d'utilisation

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Foreword

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

This fourth edition cancels and replaces the third edition (ISO 11346:2014), which has been technically revised.

The main changes are as follows:

— the accuracy via the use of a calculation method has been improved;

— the coefficient of determination and definition of a minimum value, which leads to significant improvement of regression curve accuracy and allows extrapolation to longer time periods has been introduced;

— the accuracy of test parameters has been increased;

— the formula to calculate the activation energy has been corrected;

— the threshold value (compression set) for seals has been introduced;

— different time-temperature collectives closer to real-world conditions have been introduced.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The rate of a chemical reaction normally increases with increasing temperature. By exposing test pieces to a series of elevated temperatures, the relation between the rate of degradative mechanisms and temperature can be deduced. Estimates can then be made by extrapolation, for a given temperature, of the degree of degradation after a given time or the time required to reach a given degree of degradation.

The reaction rate-temperature relationship can often be represented by the Arrhenius equation. The reaction rate at any given temperature is obtained from the change in the value of a selected property with exposure time at that temperature. The reaction rate can be represented by the time to a particular degree of degradation (threshold value) and can be the only practical measure if the property-temperature relation is complex.

The Arrhenius approach is only suitable for chemical degradation reactions and can give incorrect results for tests where physical (viscoelastic) changes cannot easily be separated from chemical changes.

An alternative approach for rubbers is to use the Williams Landel Ferry (WLF) equation. This equation performs a time-temperature transformation, and no assumptions are made as to the form of the property-time relation at any temperature. Hence, in principle, it can be applied to any physical property, including set and relaxation, or where the property/time relation is complex. Further explanation of the use of the WLF equation can be found in Reference [1].

NOTE The term equation is used for the relationships referred to here as formula.

Rubber, vulcanized or thermoplastic — Estimation of life-time and maximum temperature of use

1 Scope

This document specifies the principles and procedures for estimating the thermal endurance of rubbers from the results of exposure to elevated temperatures for long periods.

Two approaches are specified (see Introduction):

— one using the Arrhenius equation;

— the other using the WLF equation.

In this document, the estimation of thermal endurance is based solely on the change in selected properties resulting from periods of exposure to elevated temperatures. The various properties of rubbers change at different rates on thermal ageing, hence comparison between different rubbers can only be made using the same properties.

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 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

3 Terms and definitions

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

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

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

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

3.1
life-time
time at which the material under test has reached the specified *threshold value* (3.4) for the property tested at the temperature of use or a time-temperature collective (respective to climate for outside application) closest to reality

3.1.1
life-time at a given temperature
life-time at a given service temperature (e.g. 25 °C)
time obtained by extrapolation of the line to that temperature

3.1.2
life-time at a given time-temperature collective
life-time at a given temperature (3.1.1) respectively at reference temperature divided by the *ageing factor* (3.2)

