

Physical testing of rubber —

Part A60.1: Curemetering — Guide to the use of curemeters

ICS 83.060

National foreword

This British Standard reproduces ISO 6502:1999 and implements it as the UK national standard. It supersedes BS 903-A60.1:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/22, Physical testing of rubber, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Additional information

The major changes in this revision compared with the 1996 edition of BS 903-A60.1 are the inclusion of a general arrangement for a sealed torsion-shear flat-plate-die rotorless curemeter (Figure 7) and additional references in the informative annex on the effect of thermal parameters on measured cure properties (annex A).

Definitions for some of the curemeter terms used in this Guide are given in BS 3558-1 (BS ISO 1382).

ISO 3417 (Measurement of vulcanization characteristics with the oscillating disc curemeter), is dual numbered as BS 903-A60.2.

Cross-references

The British Standards which implement international publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, the ISO title page, pages ii to iv, pages 1 to 19 and a back cover.

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Rubber — Guide to the use of curemeters

Caoutchouc — Guide pour l'emploi des rhéomètres



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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 6502 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Physical and degradation tests*.

This third edition cancels and replaces the second edition (ISO 6502:1991), which has been technically revised.

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

Introduction

Whilst reviewing the previous edition of this International Standard, it became clear that a number of different curemeters were available and that significant developments had taken place, especially with the rotorless types. Rather than specify individual rotorless instruments, possibly restricting future developments, it was felt that a more general document was required. Accordingly, it was decided to provide guidance and assistance in the design and use of curemeters generally.

Rubber — Guide to the use of curemeters

WARNING — Persons using this International 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 to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This International Standard provides guidance on the determination of vulcanization characteristics of rubber compounds by means of curemeters.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1382:1996, *Rubber — Vocabulary*.

ISO 3417:1991, *Rubber — Measurement of vulcanization characteristics with the oscillating disc curemeter*.

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 1382 apply, plus the following:

3.1

oscillating-disc curemeter

ODC

a curemeter consisting of a biconical disc oscillated within a temperature-controlled die cavity containing the test piece

3.2

rotorless curemeter

RCM

a curemeter consisting of two dies forming a temperature-controlled cavity, one of which is moved relative to the other to apply a stress or strain to the test piece

NOTE Types of rotorless curemeter are listed in clause 5 and illustrated in Figures 3 to 7.

3.3 marching-modulus cure

a type of vulcanization during which the modulus does not reach a maximum value but, after a rapid rise, continues to rise slowly at the vulcanization temperature

3.4 vulcanization characteristics

characteristics which may be taken from a vulcanization curve (see Figure 1).

NOTE More explanations are given in clause 4.

3.5 stiffness

a general term used for modulus or resistance to stress

NOTE Force and torque have not been defined since they have a generally accepted scientific meaning.

4 Basic principles

The properties of a rubber compound change during the course of vulcanization, and the vulcanization characteristics can be determined by measuring properties as a function of time and temperature. Vulcanization characteristics are most commonly determined using instruments known as curemeters in which a cyclic stress or strain is applied to a test piece and the associated strain or force is measured. Normally, the test is carried out at a predetermined constant temperature and the measure of stiffness recorded continuously as a function of time.

The stiffness of the rubber increases as vulcanization proceeds. Vulcanization is complete when the recorded stiffness rises to a plateau value or to a maximum and then declines (see Figure 1). In the latter case, the decrease in stiffness is caused by reversion. In cases where the recorded stiffness continues to rise (marching-modulus cure), vulcanization is deemed to be complete after a specified time. The time required to obtain a vulcanization curve is a function of the test temperature and the characteristics of the rubber compound. Curves analogous to Figure 1 are obtained for a curemeter in which strain is measured.

The following vulcanization characteristics can be taken from the measure of stiffness against time curve (Figure 1):

Minimum force or torque	F_L or M_L
Force or torque at a specified time t	F_t or M_t
Scorch time (time to incipient cure)	t_{sx}
Time to a percentage y of full cure from minimum force or torque	$t'_c(y)$
Plateau force or torque	F_{HF} or M_{HF}
Maximum force or torque (reverting cure)	F_{HR} or M_{HR}
Force or torque value attained after a specified time (marching-modulus cure)	F_H or M_H

The minimum force or torque F_L or M_L characterizes the stiffness of the unvulcanized compound at the curing temperature.

The scorch time (time to incipient cure) t_{sx} is a measure of the processing safety of the compound.

The time $t'_c(y)$ and the corresponding forces or torques give information on the progress of cure. The optimum cure is often taken as $t'_c(90)$.

The highest force or torque is a measure of the stiffness of the vulcanized rubber at the curing temperature.

NOTE The term F denotes force, and the term M denotes torque.