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Epoxidized natural rubber — Specifications

Caoutchouc naturel époxydé — Spécifications

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Contents

Page

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.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 3, *Raw materials (including latex) for use in the rubber industry*.

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

Significant developments have taken place in the supply of raw natural rubber, especially in relation to the number of different grades that are technically specified. The constant viscosity (CV), latex (L) and gel content (LoV) grades have been added in addition to the initial grades covered in the first edition of ISO 2000. The development and availability of physical and/or chemically modified grades are now reported in the technical literature with the aim to expand natural rubber (NR) applications in rubber products. Demand and acknowledgment of these modified grades grow from year to year. On this note, it is important to establish a standard reference for the specification related to these modified natural rubber grades. In this document the emphasis is given to the epoxidized natural rubber (ENR) grade produced through a chemical modification route on natural rubber.

This document encompasses natural raw rubber specification for ENR produced through a chemical modification route known as epoxidation reaction. Typically, the most economical epoxidation reaction route is through the in situ peracid method. Through the process the peracid is formed from hydrogen peroxide and formic acid. The epoxidation reaction involves with substitution of the NR double bond structure (C=C) with epoxy ring structure (C-O-C) which later determines the grade of the ENR rubber. In general, any level of epoxidation can be produced according to the specific formulation. However, currently only two grades (25 mol% and 50 mol%) are available commercially. Different level of epoxidation in the ENR rubber specifies its usage in rubber product applications. The ENR acronym identifies and distinguishes the grades from other natural rubber grades. Unlike other technically specified rubber grades, the processing of the ENR material requires meticulous control during the process because every step is critical and might affect the properties of the final product.

This document encompasses some rubbers that are better defined elsewhere. For more precise specifications, reference can be made to such specifications in particular cases which may be found in national standards or in the literature of manufacturers of these ENR grades.

Epoxidized natural rubber — Specifications

1 Scope

This document specifies the physical and chemical requirements of epoxidized natural rubber (ENR) based on the epoxidation level of the natural rubber.

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 247-1, *Rubber — Determination of ash — Part 1: Combustion method*

ISO 289-1, *Rubber, unvulcanized — Determinations using a shearing-disc viscometer — Part 1: Determination of Mooney viscosity*

ISO 1656, *Rubber, raw natural, and rubber latex, natural — Determination of nitrogen content*

ISO 1795, *Rubber, raw natural and raw synthetic — Sampling and further preparative procedures*

ISO 4660, *Rubber, raw natural — Colour index test*

ISO 5260, *Epoxidized natural rubber — Determination of epoxidation and ring opening level by NMR spectrometry*

ISO 20299-2, *Film for wrapping rubber bales — Part 2: Natural rubber*

ASTM D3418, *Standard Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry*

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
epoxidized natural rubber
ENR
natural rubber which has been chemically treated and modified through the addition of oxygen atom onto the double bond structure of the *cis*-1,4-polyisoprene to form three-membered ether (C-O-C) in a cyclic form by a process known as epoxidation reaction

3.2
whole field latex
WF
latex material derived from *Hevea brasiliensis* which may be diluted but is not fractionated

[SOURCE: ISO 2000:2020, 3.5]

3.3
centrifuged latex
CF
latex material derived from *Hevea brasiliensis*, concentrated to 60 % dry rubber content using methods of centrifugation

3.4
epoxidation level
level and/or degree of the epoxy groups (C-O-C) in the NR structure

3.5
ring opening level
level and/or degree of ring opening due to the formation of secondary by product from uncontrolled condition of epoxidation reaction in the natural rubber structure

4 Material composition

Epoxidized natural rubber (ENR) shall be graded based on the following raw materials:

— whole field latex;

— centrifuged latex.

The ENR is composed of a polyisoprene backbone with different levels of epoxy structure after being chemically modified in the latex stage and subsequently dried to a solid form.

5 Grade structure

The ENR grade is based on the level of epoxidation and the type of material used in its production (see Table 1).

Table 1 — Grades of ENR

Raw material	Characteristic	Grades
Whole field latex treated with stabilisers and epoxidation agents	With specification on nitrogen value	ENR 25 FL ENR 50 FL
Centrifuged latex treated with stabilisers and epoxidation agents	With no specification on nitrogen value	ENR 25 ENR 50
NOTE For the grades of ENR 25 and ENR 50, the numerals represent the mole percentage of the epoxide level i.e. 25 mol% and 50 mol% of the unsaturation in the rubber are converted through modification to the epoxide groups.		

6 Specification of requirement

Any specific values for physical and chemical properties shall be based upon the grade and type of raw materials according to Table 2.

Table 2 — Specification of ENR

Raw material	Latex concentrate		Field latex		Test method
Properties	Grade		Grade		
	ENR 25	ENR 50	ENR 25 FL	ENR 50 FL	
Ash content maximum % (mass fraction)	0,25	0,25	0,25	0,25	ISO 247-1
NOTE N/A means not available.					

Table 2 *(continued)*

Raw material	Latex concentrate		Field latex		Test method
Properties	Grade		Grade		
	ENR 25	ENR 50	ENR 25 FL	ENR 50 FL	
Nitrogen content maximum % (mass fraction)	N/A	N/A	0,15	0,15	ISO 1656
Epoxidation level % (mole fraction)	25 ± 2	50 ± 2	25 ± 2	50 ± 2	ISO 5260[1]
Ring opening level maximum % (mole fraction)	2,0	4,0	2,0	4,0	
Mooney viscosity ML (1+4) at 100 °C	70 to 100	70 to 100	70 to 100	70 to 100	ISO 289-1
Glass transition temperature °C	-45 ± 2	-22 ± 2	-45 ± 2	-22 ± 2	ASTM D3418
Lovibond colour index maximum (optional)	4,0	4,0	4,0	4,0	ISO 4660
NOTE N/A means not available.					

7 Sampling

The ENR shall be sampled in accordance with ISO 1795, unless otherwise agreed between the interested parties.

Each sample derived from the lot shall comply with the requirements agreed for that grade of ENR.

8 Packaging

The ENR should normally be packaged in bales of nominal mass 33,3 kg or 35 kg (tolerance ±0,5 %).

NOTE 1 Since 36 bales of 33,3 kg make up a 1,2 tonne, it can be the preferred size.

Each bale shall be

— identified,

— marked, and

— wrapped either in polyethylene film as specified in ISO 20299-2 or in some other form of packaging as agreed between the interested parties.

NOTE 2 The thickness of non-strippable polyethylene film specified in ISO 20299-2:2017, 5.1, is 0,03 mm to 0,05 mm. However, on agreement between the interested parties, a maximum thickness of 0,065 mm can be used especially if the removal of the packaging film is desired.