
Magnetni materiali - 12. del: Metode preskušanja za oceno toplotne vzdržljivosti površinskih izolacijskih premazov na električnih jeklenih trakovih in pločevinah

Magnetic materials - Part 12: Methods of test for the assessment of thermal endurance of surface insulation coatings on electrical steel strip and sheet

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PREVIEW

Matériaux magnétiques - Partie 12: Guide aux méthodes de caractérisation de la tenue en température de l'isolation interlaminaire

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68/698/CDV

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SECRETARIAT: Germany	SECRETARY: Mr Richard Daniel Knobloch
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
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<p>Attention IEC-CENELEC parallel voting</p> <p>The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.</p> <p>The CENELEC members are invited to vote through the CENELEC online voting system.</p>	

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TITLE:

Magnetic materials - Part 12: Methods of test for the assessment of thermal endurance of surface insulation coatings on electrical steel strip and sheet

PROPOSED STABILITY DATE: 2028

NOTE FROM TC/SC OFFICERS:

This document was prepared by the Project Leader together with the Project Team on the basis of the second CD, 68/679/CD, and the related observations presented in 68/694/CC. The Chair decided to proceed to the CDV according to the high degree of consensus achieved.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MAGNETIC MATERIALS –

Part 12: Methods of test for the assessment of the thermal endurance of surface insulation coatings on electrical steel strip and sheet

FOREWORD

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IEC 60404-12 has been prepared by IEC technical committee 68: Magnetic alloys and steels. It is an International Standard.

This second edition cancels and replaces the first edition published in 1992. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the method of test for adhesion has been modified to match to the method of bend test specified in ISO 1519:2011 using a cylindrical mandrel of 32 mm in diameter instead of the 30 mm diameter mandrel specified in the previous edition of this document;

- 96 b) the method of test for interlaminar insulation resistance has been modified to match to the
97 method specified in IEC 60404-11 and the modified Franklin test has been removed;
- 98 c) the method of test for compressibility has been modified to match to the method of test for
99 stacking factor specified in IEC 60404-13;
- 100 d) the concept of “resistance grades” has been removed;
- 101 e) the clamping pressure to be used at temperature ratings above 500 °C has been reduced to
102 (0,01 ± 0,001) N/mm².
- 103 f) The testing for continuous exposure has been made a subject to an agreement between the
104 manufacturer and the purchaser and the procedure has been moved to an informative Annex
105 A.

106 The text of this International Standard is based on the following documents:

FDIS	Report on voting
68/XX/FDIS	68/XX/RVD

107
108 Full information on the voting for the approval of this standard can be found in the Voting
109 Reports indicated in the above table.

110 The language used for the development of this International Standard is English.

111 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
112 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available
113 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are
114 described in greater detail at <http://www.iec.ch/standardsdev/publications>.

115 A list of all parts in the IEC 60404 series, published under the general title *Magnetic materials*,
116 can be found on the IEC website.

117 The committee has decided that the contents of this document will remain unchanged until the
118 stability date indicated on the IEC website under “webstore.iec.ch” in the data related to the
119 specific document. At this date, the document will be

- 120 • reconfirmed,
121 • withdrawn,
122 • replaced by a revised edition, or
123 • amended.

124

125 The National Committees are requested to note that for this document the stability date
126 is 2028.

127 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED
128 AT THE PUBLICATION STAGE.

129

130

131

INTRODUCTION

132 The surface insulation coatings on electrical steel strip and sheet are sometimes exposed to
133 elevated temperatures in service or during processing by the purchaser. Therefore, the thermal
134 endurance of the surface insulation coating is important.

135 Physicochemical models postulated for the aging processes lead to the almost universal
136 assumption of the Arrhenius equations to describe the rate of aging (see Annex A and IEC
137 60216-1:2013).

138 Since the measurement of the properties of surface insulation coatings at elevated
139 temperatures is expensive and time-consuming, the thermal endurance of a coating is usually
140 assessed by evaluating a specified coating property before and after a heat treatment.

141

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1c69-4fd7-a378-29471a9bf8e3/osist-pren-iec-60404-
12-2022](https://standards.iteh.ai/catalog/standards/sist/11e6dfd8-1c69-4fd7-a378-29471a9bf8e3/osist-pren-iec-60404-12-2022)

MAGNETIC MATERIALS –

Part 12: Methods of test for the assessment of the thermal endurance of surface insulation coatings on electrical steel strip and sheet

1 Scope

This part of IEC 60404 is applicable to surface insulation coatings on electrical steel strip and sheet classified in IEC 60404-1-1.

The purpose of this document is to define the general principles and technical details of the tests for the assessment of the thermal endurance of surface insulation coatings on electrical steel strip and sheet.

The assessment is made by evaluating the change of a specified property of the surface insulation coating due to a heat treatment at a specified temperature up to 850 °C and a specified duration time up to 2 500 h. The specified property is measured at an ambient temperature of (23 ± 5) °C both without heat treatment and after heat treatment.

This document is applicable to the following properties of surface insulation coatings:

- adhesion;
- surface insulation resistance;
- stacking factor.

This document is not applicable to other properties of surface insulation coatings, e.g. welding properties, or to other effects e.g. discoloration and off-gassing, which can be caused by exposure to elevated temperatures.

NOTE Some of the tests take a very long time to perform and therefore they may not be suitable for acceptance tests of material supplied on a specific order.

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.

IEC 60050-121, *International Electrotechnical Vocabulary – Part 121: Electromagnetism*

IEC 60050-131, *International Electrotechnical Vocabulary – Part 131: Circuit theory*

IEC 60050-221, *International Electrotechnical Vocabulary – Chapter 221: Magnetic materials and components*

IEC 60404-1-1, *Magnetic materials – Part 1-1: Classification – Surface insulations of electrical steel sheet, strip and laminations*

IEC 60404-11, *Magnetic materials – Part 11: Methods of measurement of the surface insulation resistance of electrical steel strip and sheet*

182 IEC 60404-13, *Magnetic materials – Part 13: Methods of measurement of resistivity, density*
183 *and stacking factor of electrical steel strip and sheet*

184 ISO 1519:2011, *Paints and varnishes – Bend test (cylindrical mandrel)*

185 3 Terms and definitions

186 For the purposes of this document, the terms and definitions given in IEC 60050-121, IEC
187 60050-131, IEC 60050-221 and the following apply.

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

- 190 • IEC Electropedia: available at <http://www.electropedia.org/>
- 191 • ISO Online browsing platform: available at <http://www.iso.org/obp>

192 3.1

193 **Temperature/time performance designation T/t**

194 designation consisting of a temperature T , expressed in °C, and a duration of time t , expressed
195 in h, of a heat treatment that a surface insulation coating can withstand with respect to a specified
196 coating property

197 NOTE 1 to entry: This designation serves for rating of the thermal endurance of a surface insulation coating with
198 respect to specified coating properties.

199 NOTE 2 to entry: More than one designation can be assigned to a coating.

200 EXAMPLE The designations 200/2500 and 800/2 mean that the surface insulation coating can withstand heat
201 treatments at 200 °C for 2 500 h and 800 °C for 2 h respectively with respect to a specified coating property.

202 4 General principles

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https://standards.iteh.ai/catalog/standards/sist/11e6dfd8-1c69-4fd7-a378-29471a9bf8e3/osist-pren-iec-60404-12-2022](https://standards.iteh.ai/catalog/standards/sist/11e6dfd8-1c69-4fd7-a378-29471a9bf8e3/osist-pren-iec-60404-12-2022)

203 4.1 General

204 The thermal endurance of a surface insulation coating shall be assessed by evaluating changes
205 of specified coating properties due to a heat treatment at a specified temperature T °C for a
206 specified duration time t h. The coating properties shall be measured at an ambient temperature
207 of (23 ± 5) °C.

208 The thermal endurance for the following coating properties shall be assessed separately:

- 209 – adhesion;
- 210 – surface insulation resistance;
- 211 – stacking factor.

212 4.2 Preparation of clamped stacks of test specimens

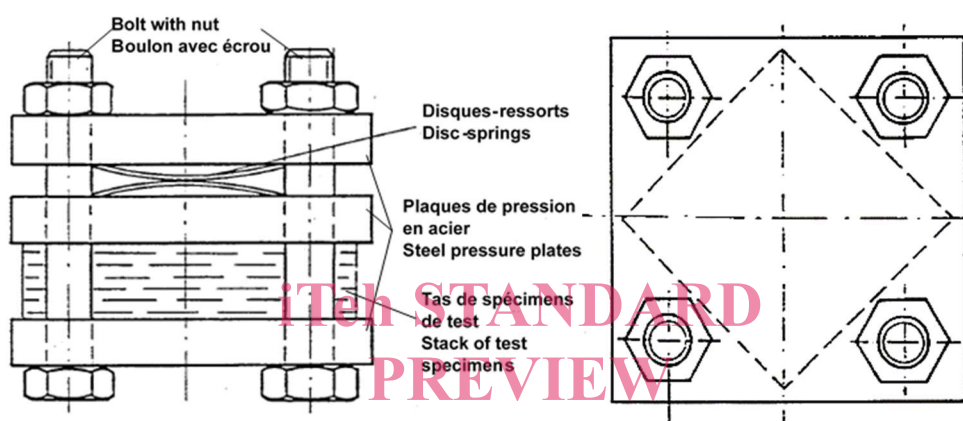
213 4.2.1 Procedure of stacking test specimens

214 The test specimens shall be stacked between two similar sized or larger sheets made of the
215 same material as the test specimens. The stack shall then be clamped between two steel
216 pressure plates. The dimensions of the steel pressure plates shall be larger than the size of the
217 part of the test specimens to be tested, e.g. only the part of the test specimens that will be bent
218 at the bend test needs to be clamped (see 6.3).

219 4.2.2 Clamping stacks for temperature ratings up to 500 °C

220 The stack of test specimens shall be clamped homogeneously between the two steel pressure
221 plates under a pressure of $(1 \pm 0,1)$ N/mm². Figure 1 illustrates an example of a clamped stack
222 for 100 mm square test specimens for temperature rating up to 500 °C.

223 The pressure shall be applied using suitable calibrated equipment such as a press, a tensile
224 test machine or hydraulic jacks. The bolts shall be tightened while applying the pressure. The
225 disk-springs, the bolts, the nuts and the steel pressure plates shall be made of suitable
226 materials which can maintain a substantially constant pressure while the test specimens are
227 subjected to the heat treatment.



CEI-IEC 1108/92

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229 **Figure 1 – Example of clamped stack for 100 mm square test specimens**

230 In case the clamping method using screws causes problems during the test, the manufacturer
231 and the purchaser can agree at the time of enquiry and order on using the clamping method for
232 above 500 °C described in 4.2.3.

233 4.2.3 Clamping stacks for temperature ratings above 500 °C

234 The stack of test specimens shall be clamped homogeneously between the two steel pressure
235 plates under a pressure of $(0,01 \pm 0,001)$ N/mm².

236 The pressure shall be applied by using a dead weight or by an externally applied force
237 transmitted by suitable thermally insulated rods from the outside of the furnace used for the
238 heat treatment.

239 4.3 Heat treatment

240 4.3.1 For time ratings up to 2 500 hours

241 The clamped stack shall be placed in a furnace at near ambient temperature. The furnace shall
242 be heated to the temperature T °C $\pm 1,5$ % with a heating rate not exceeding 200 °C/h.

243 When the furnace reaches the temperature T °C, this temperature shall be held for a specified
244 duration time of t h ± 1 %, where T and t constitute the temperature/time performance
245 designation T/t .

246 The furnace shall have enough power and heating capacity to ensure that the surface of the
247 clamped stacked reaches at least 2,5 % below the temperature T °C when the furnace reaches
248 the temperature T °C. The furnace capacity shall be confirmed, e.g. by means of a thermocouple
249 applied to the clamped stack. A furnace with forced atmosphere convection is recommended.