

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

---

**Resin based reactive compounds used for electrical insulation –  
Part 2: Methods of test**

**Composés réactifs à base de résines utilisés comme isolants électriques –  
Partie 2: Méthodes d'essai**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2023 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

#### IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

---

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Recherche de publications IEC -

##### [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



IEC 60455-2

Edition 4.0 2023-07

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

---

**Resin based reactive compounds used for electrical insulation –  
Part 2: Methods of test**

**Composés réactifs à base de résines utilisés comme isolants électriques –  
Partie 2: Méthodes d'essai**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

---

ICS 17.220.99, 29.035.01

ISBN 978-2-8322-7283-1

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

|   |    |
|---|----|
| FOREWORD.....   | 5  |
| INTRODUCTION.....   | 7  |
| 1 Scope.....  | 8  |
| 2 Normative references .....  | 8  |
| 3 Terms and definitions .....   | 11 |
| 4 General notes on methods of test .....  | 11 |
| 4.1 Preparation and conditioning.....   | 11 |
| 4.2 Sequence of tests .....   | 12 |
| 4.3 Test report .....   | 12 |
| 5 Methods of test for reactive compounds and their components .....                       | 12 |
| 5.1 Flash point.....  | 12 |
| 5.2 Density .....   | 12 |
| 5.3 Viscosity .....   | 12 |
| 5.4 Viscosity after storing at elevated temperature.....                                  | 12 |
| 5.5 Content of volatile organic components.....   | 13 |
| 5.6 Isothermal increase of viscosity (processing time) .....                              | 13 |
| 5.7 Shelf life .....  | 13 |
| 5.8 Colour.....   | 13 |
| 5.9 Softening temperature .....   | 14 |
| 5.10 Ash content.....   | 14 |
| 5.11 Filler content.....  | 14 |
| 5.12 Chlorine content.....  | 14 |
| 5.12.1 Total chlorine content of unsaturated polyesters and epoxide resins.....           | 14 |
| 5.12.2 Inorganic chlorine content of epoxide resins and glycidyl esters .....             | 14 |
| 5.12.3 Easily saponifiable chlorine content of epoxide resins and related materials ..... | 14 |
| 5.13 Tendency of crystallisation.....   | 14 |
| 5.14 Epoxide equivalent of epoxide resins .....   | 14 |
| 5.15 Content of isocyanate .....  | 14 |
| 5.16 Water content (Karl Fischer method).....   | 14 |
| 5.17 Hydroxyl value .....   | 15 |
| 5.17.1 Polyester resins.....  | 15 |
| 5.17.2 Resins other than polyester .....  | 15 |
| 5.18 Acid value of polyester resins .....   | 15 |
| 5.19 Amount of double bonds of unsaturated polyester and acrylate resins .....            | 15 |
| 5.20 Acid and acid-anhydride content of acid-anhydride hardeners.....                     | 15 |
| 5.21 Amine value .....  | 15 |
| 5.22 Pot life .....   | 15 |
| 5.22.1 General .....  | 15 |
| 5.22.2 Resinous compounds for cable accessories.....                                      | 15 |
| 5.23 Gel time .....   | 16 |
| 5.23.1 Unsaturated polyester based compounds .....  | 16 |
| 5.23.2 Phenolic resin based compounds.....  | 16 |
| 5.23.3 Other compounds .....  | 16 |
| 5.24 Exothermic temperature rise .....  | 16 |
| 5.24.1 Unsaturated polyester based compounds .....  | 16 |
| 5.24.2 Resinous compounds for cable accessories.....                                      | 16 |

|        |   |    |
|--------|---|----|
| 5.25   | Total volume shrinkage of epoxide and unsaturated polyester based compounds ..... | 17 |
| 5.26   | Curing in presence of water .....   | 17 |
| 5.26.1 | General .....   | 17 |
| 5.26.2 | Apparatus and materials .....   | 17 |
| 5.26.3 | Pouring device .....  | 17 |
| 5.26.4 | Procedure .....   | 17 |
| 5.26.5 | Test report .....   | 18 |
| 5.27   | Determination of the degree of curing .....                                       | 19 |
| 5.28   | Curing in thick layer and emissions during curing .....                           | 19 |
| 5.28.1 | General .....   | 19 |
| 5.28.2 | Equipment .....   | 20 |
| 5.28.3 | Test specimen .....   | 20 |
| 5.28.4 | Procedure .....   | 20 |
| 6      | Methods of test for cured reactive compounds .....                                | 21 |
| 6.1    | General .....   | 21 |
| 6.2    | Test specimens .....  | 21 |
| 6.2.1  | General .....   | 21 |
| 6.2.2  | Preparation of the reactive compound .....  | 21 |
| 6.2.3  | Preparation of test specimens .....   | 22 |
| 6.2.4  | Type and number of test specimens .....   | 22 |
| 6.3    | Density .....   | 22 |
| 6.4    | Mechanical properties .....   | 22 |
| 6.4.1  | Tensile properties .....  | 22 |
| 6.4.2  | Compressive properties .....  | 22 |
| 6.4.3  | Flexural properties .....   | 23 |
| 6.4.4  | Impact strength .....   | 23 |
| 6.4.5  | Hardness .....  | 23 |
| 6.5    | Thermal properties .....  | 23 |
| 6.5.1  | Bond strength at elevated temperature .....                                       | 23 |
| 6.5.2  | Linear thermal expansion .....  | 23 |
| 6.5.3  | Thermal conductivity .....  | 23 |
| 6.5.4  | Glass transition .....  | 24 |
| 6.5.5  | Flammability .....  | 24 |
| 6.5.6  | Thermal shock .....   | 24 |
| 6.5.7  | Dry heat resistance of resins for cable accessories – Method of test .....        | 24 |
| 6.5.8  | Wet heat resistance of resins for cable accessories .....                         | 25 |
| 6.5.9  | Loss of mass .....  | 27 |
| 6.5.10 | Temperature index .....   | 28 |
| 6.6    | Chemical properties .....   | 29 |
| 6.6.1  | Water absorption .....  | 29 |
| 6.6.2  | Effect of liquid chemicals .....  | 29 |
| 6.6.3  | Resistance to mould growth .....  | 29 |
| 6.6.4  | Water vapour permeability .....   | 29 |
| 6.7    | Electrical properties .....   | 29 |
| 6.7.1  | Effect of water immersion on volume resistivity .....                             | 29 |
| 6.7.2  | Dielectric dissipation factor ( $\tan \delta$ ) and relative permittivity .....   | 29 |
| 6.7.3  | Break down voltage and electric strength .....                                    | 29 |
| 6.7.4  | Proof tracking index (PTI) .....  | 31 |

|   |    |
|---|----|
| 6.7.5 Electrolytic corrosion .....  | 31 |
| Annex A (informative) Health and safety .....                                 | 34 |
| Bibliography.....   | 35 |
| Figure 1 – Examination grid .....   | 18 |
| Figure 2 – Position of examination grid on the specimen.....                  | 19 |
| Figure 3 – Example of electrode arrangement for flexible cured compound ..... | 32 |
| Figure 4 – Example of electrode arrangement for rigid cured compound .....    | 33 |
| Table 1 – Condition of the top side.....                                      | 20 |
| Table 2 – Condition of the bottom side.....                                   | 20 |
| Table 3 – Condition of the interior .....                                     | 20 |
| Table 4 – Voids.....  | 21 |

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RESIN BASED REACTIVE COMPOUNDS USED  
FOR ELECTRICAL INSULATION –****Part 2: Methods of test****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60455-2 has been prepared by IEC technical committee 15: Solid electrical insulating materials. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2015. This edition constitutes a technical revision.

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

- a) Introduction of test methods related to IEC 60455-3-8;
- b) Additional and updated test methods for resins.

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

| Draft        | Report on voting |
|--------------|------------------|
| 15/1006/FDIS | 15/1015/RVD      |

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

A list of all parts in the IEC 60455 series, published under the general title *Resin based reactive compounds used for electrical insulation*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under [webstore.iec.ch](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.



## INTRODUCTION

This part of IEC 60455 is one of a series which deals with solvent-free resin based reactive compounds and their components used for electrical insulation.

The series consists of three parts:

- Part 1: Definitions and general requirements;
- Part 2: Methods of test;
- Part 3: Specifications for individual materials.

# RESIN BASED REACTIVE COMPOUNDS USED FOR ELECTRICAL INSULATION –

## Part 2: Methods of test

### 1 Scope

This part of IEC 60455 specifies methods of test to be used for testing resin based reactive compounds, their components and cured compounds used for electrical insulation.

### 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 (all parts), *International Electrotechnical Vocabulary (available at <http://www.electropedia.org>)*

IEC 60068-2-10:2005, *Environmental testing – Part 2-10: Tests – Test J and guidance: Mould growth*

IEC 60112:2020, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60216 (all parts), *Electrical insulating materials – Thermal endurance properties*

IEC 60243-1:2013, *Electric strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60296:2020, *Fluids for electrotechnical applications – Mineral insulating oils for electrical equipment*

IEC 60426:2007, *Electrical insulating materials – Determination of electrolytic corrosion caused by insulating materials – Test methods*

IEC 60455-1:1998, *Resin based reactive compounds used for electrical insulation – Part 1: Definitions and general requirements*

IEC 60455-3 (all parts), *Resin based reactive compounds used for electrical insulation – Part 3: Specifications for individual materials*

IEC 60455-3-8:2021, *Resin based reactive compounds used for electrical insulation – Part 3-8: Specifications for individual materials – Resins for cable accessories*

IEC 60695-11-10:2013, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60814:1997, *Insulating liquids – Oil-impregnated paper and pressboard – Determination of water by automatic coulometric Karl Fischer titration*