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



IEC 60455-2:2023-07(en-fr)



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# RESIN BASED REACTIVE COMPOUNDS USED FOR ELECTRICAL INSULATION –

## Part 2: Methods of test

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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. The main document types developed by IEC are described in greater detail at 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 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- withdrawn,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*

IEC 61033:1991, *Test methods for the determination of bond strength of impregnating agents to an enamelled wire substrate*

IEC 61099:2010, *Insulating liquids – Specifications for unused synthetic organic esters for electrical purposes*

ISO 37:2011, *Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties*

ISO 62:2008, *Plastics – Determination of water absorption*

ISO 75 (all parts), *Plastics and ebonite – Determination of temperature of deflection under load*

ISO 175:2010, Plastics – *Methods of test for the determination of the effects of immersion in liquid chemicals*

ISO 178:2010, *Plastics – Determination of flexural properties*

ISO 179-1:2010, *Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test*

ISO 179-2:1997, *Plastics – Determination of Charpy impact properties – Part 2: Instrumented impact test*

ISO 291, *Plastics – Standard atmospheres for conditioning and testing*

ISO 306:2013, *Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST)*

ISO 527 (all parts), *Plastics – Determination of tensile properties*

ISO 584:1982, *Plastics – Unsaturated polyester resins – Determination of reactivity at 80 degrees C (conventional method)*

ISO 604:2002, *Plastics – Determination of compressive properties*

ISO 868:2003, *Plastics and ebonite – Determination of indentation hardness by means of a durometer (Shore hardness)*

ISO 1183-1:2019, *Plastics – Methods for determining the density of non-cellular plastics – Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 1513:2010, *Paints and varnishes – Examination and preparation of test samples*

ISO 1523:2002, *Determination of flash point – Closed cup equilibrium method*

ISO 1675:1985, *Plastics – Liquid resins – Determination of density by the pycnometer method*

ISO 2039-1:1993, *Plastics – Determination of hardness – Part 1: Ball indentation method*

ISO 2114:2000, *Plastics (polyester resins) and paints and varnishes (binders) – Determination of partial acid value and total acid value*

ISO 2431:1993, *Paints and varnishes – Determination of flow time by use of flow cups*

ISO 2535:1997, *Plastics – Unsaturated polyester resins – Measurement of gel time at 25 degrees C*

ISO 2554:1997, *Plastics – Unsaturated polyester resins – Determination of hydroxyl value*

ISO 2555:1989, *Plastics – Resins in the liquid state or as emulsions or dispersions – Determination of apparent viscosity using a single cylinder type rotational viscometer method*

ISO 2592:1973, *Petroleum products – Determination of flash and fire points – Cleveland open cup method*

ISO 3001:1997, *Plastics – Epoxy compounds – Determination of epoxy equivalent*

ISO 3219:1993, *Plastics – Polymers/resins in the liquid state or as emulsions or dispersions – Determination of viscosity using a rotational viscometer with defined shear rate*

ISO 3451-1:1997, *Plastics – Determination of ash – Part 1: General methods*

ISO 3521:1997, *Plastics – Unsaturated polyester and epoxy resins – Determination of overall volume shrinkage*

ISO 3679:1983, *Paints, varnishes, petroleum and related products – Determination of flashpoint – Rapid equilibrium method*

ISO 4573:1978, *Plastics – Epoxide resins and glycidyl esters – Determination of inorganic chlorine*

ISO 4583:1998, *Plastics – Epoxide resins and related materials – Determination of easily saponifiable chlorine*

ISO 4615:1979, *Plastics – Unsaturated polyesters and epoxide resins – Determination of total chlorine content*

ISO 4625:1980, *Binders for paints and varnishes – Determination of softening point – Ring-and-ball method*

ISO 4895, *Plastics – Liquid epoxy resins – Determination of tendency to crystallize*

ISO 7056, *Plastics laboratory ware – Beakers*

ISO 9396:1997, *Plastics – Phenolic resins – Determination of the gel time of resols under specific conditions using automatic apparatus*

ISO 11357-2:1999, *Plastics – Differential scanning calorimetry (DSC) – Part 2: Determination of glass transition temperature and step height*

ISO 11359-2:1999, *Plastics – Thermomechanical analysis (TMA) – Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

ISO 11359-3:2002, *Plastics – Thermomechanical analysis (TMA) – Part 3: Determination of penetration temperature*

ISO 14896:2009, *Plastics – Polyurethane raw materials – Determination of isocyanate content*

ISO 15528:2000, *Paints, varnishes and raw materials for paints and varnishes – Sampling*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60455-1 and IEC 60050 and the following shall apply.

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

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

**3.1**
**volume resistance**
part of the insulation resistance which is due to conduction through the volume and excluding surface current

**3.2**
**volume resistivity**
volume resistance reduced to a cubical unit volume

**3.3**
**dielectric dissipation factor**
**tan δ**
numerical value of the ratio of the imaginary to the real part of the complex permittivity

**3.4**
**relative permittivity**
**$\varepsilon_r$**
ratio of the absolute permittivity to the electric constant

Note 1 to entry: In practical engineering, it is usual to employ the term ‘permittivity’ when referring to relative permittivity

## 4 General notes on methods of test

### 4.1 Preparation and conditioning

Unless otherwise specified in the relevant specification standard or in the method of test, all tests shall be carried out at atmospheric conditions in a temperature range of between 21 °C and 29 °C and a relative humidity range of between 45 % and 70 %. Before measurements are made, the sample or test specimen shall be pre-conditioned under these atmospheric conditions for a time sufficient to allow the sample or the test specimen to reach stability. For taking samples in liquid or paste form, ISO 15528 shall be applied. For preparation of such samples for testing, ISO 1513 shall be applied.

NOTE For definitions of terms for standard atmospheres, see ISO 558. The test atmosphere as specified above does not comply with any of the two standard atmospheres as specified in ISO 291 but covers both ranges inclusive of their tolerances

Normally, all requirements for a method of test are given in the description, and diagrams are intended only to illustrate one possible arrangement for conducting the test. In case of inconsistencies between this document and the specification sheets of the IEC 60455-3 series, the latter shall prevail. When another standard is invoked for a test method, reference to that standard shall be included in the report.

### 4.2 Sequence of tests

To avoid unnecessary efforts, tests shall be carried out on the samples in the following sequence:

1) tests on individual components prior to mixing;
2) tests on reactive compound just after mixing (ready to use);
3) tests on cured compound;
4) tests on cured compound after pre treatment (thermal, humidity, water etc.).

If the sample under test fails a test the following tests may become obsolete.

### 4.3 Test report

If not otherwise specified, the test report shall include the following data:

1) resin designation and identification;
2) lot number or other identification;
3) confirmation of marking and labelling according to the material safety data sheet (MSDS);
4) test results;
5) major test parameters, including conditioning and calibration, if any;
6) processing conditions used to reactive compound;
7) copy of the technical data sheet (TDS) and (MSDS).

## 5 Methods of test for reactive compounds and their components

### 5.1 Flash point

For flash point temperatures of 79 °C and above, the method given in ISO 2592 shall be used. For flash point temperatures below 79 °C, the method given in ISO 1523 shall be used with any of the closed-cup apparatus as described in Annex A of ISO 1523:2002. ISO 1523 shall be read in conjunction with ISO 3679. Two measurements shall be made on two separate samples, and the two results of the flash point shall be reported along with reference to the standards applied.

### 5.2 Density

The method given in ISO 1675 shall be used. Two measurements shall be made, and the two results of the density shall be reported.

### 5.3 Viscosity

The viscosity shall be determined with a suitable device at (23 ± 0,5) °C if not otherwise specified. If a rotating type of device is used, it shall be in accordance with ISO 2555 (Brookfield type) or with ISO 3219 (a type working at a defined shear rate). If an efflux type of equipment is used, the method of test and the flow cup shall be in accordance with ISO 2431. Two measurements shall be made, and the two results of the viscosity shall be reported, along with reference to the standards applied.

### 5.4 Viscosity after storing at elevated temperature

This method is not applicable to one-component systems or components containing hardener.

If not otherwise specified, a sample of sufficient amount is stored for (20 ± 0,5) h at a temperature of (100 ± 3) °C in a sealed container. After cooling down to room temperature the viscosity is measured according to 5.3. The increase of viscosity is calculated using the following equation: