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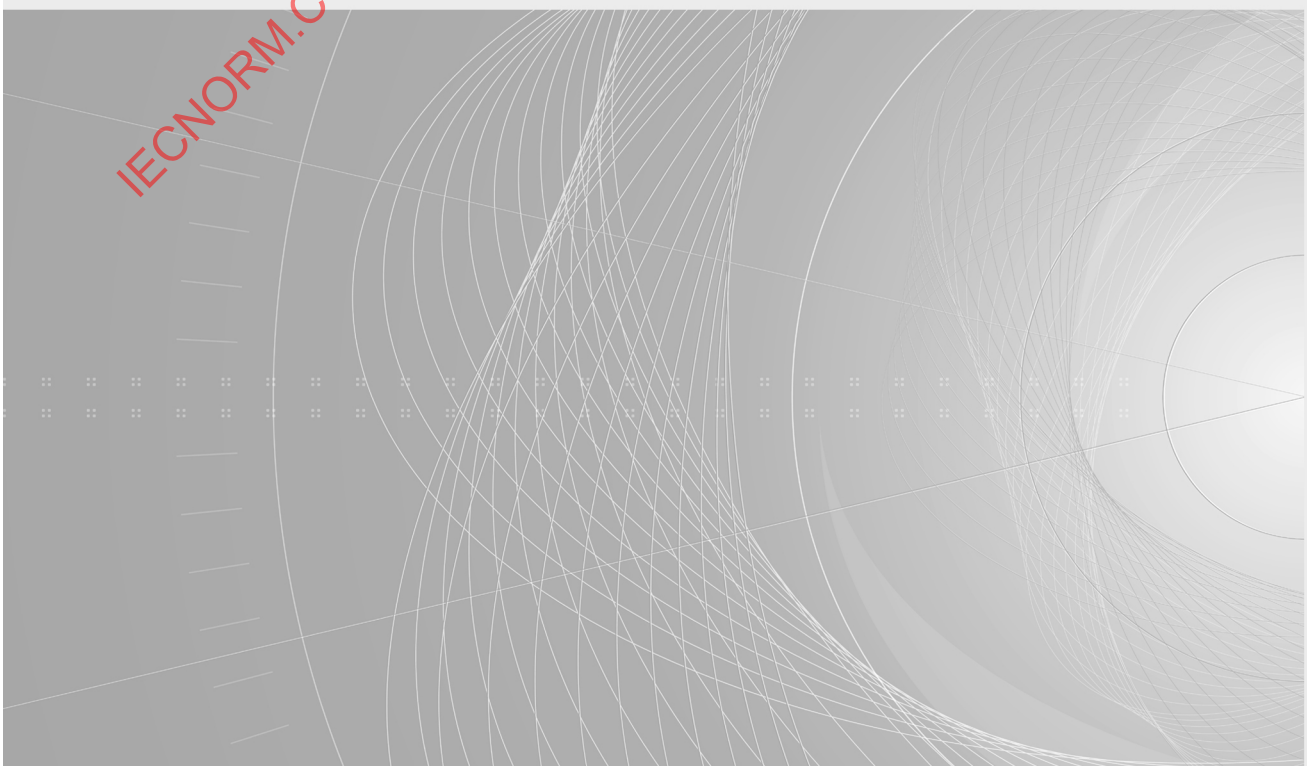
Resin based reactive compounds used for electrical insulation – Part 3-8: Specifications for individual materials – Resins for cable accessories



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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 3-8: Specifications for individual materials – Resins for cable accessories

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60455-3-8:2013. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60455-3-8 has been prepared by IEC technical committee 15: Solid electrical insulating materials.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

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

a) Clause 1: a link to assemblies according to IEC 60502-4 and EN 50393 was introduced;
b) designation: the categories, especially the mechanical ones, were redefined;
c) type tests: the testing was updated based on the chemical basis of the material;
d) type tests: additional materials were introduced;
e) Annex A: an examination grid was established.

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

FDIS	Report on voting
15/937/FDIS	15/941/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/standardsdev/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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 60455 is one of a series which deals with specifications for reactive compounds and their components for electrical insulation. This series consists of three parts:

Part 1: Definitions and general requirements (IEC 60455-1);

Part 2: Methods of test (IEC 60455-2);

Part 3: Specifications for individual materials (IEC 60455-3)

IEC 60455-3-8 is one of the specification sheets comprising Part 3 as follows:

Sheet 8: Resins for cable accessories

RESIN BASED REACTIVE COMPOUNDS USED FOR ELECTRICAL INSULATION –

Part 3-8: Specifications for individual materials – Resins for cable accessories

1 Scope

This part of IEC 60455 gives the requirements for resins for power cable accessories that conform to this specification and meet established levels of performance. However, the selection of a material by a user for a specific application ~~should~~ will be based on the actual requirements necessary for adequate performance in that application and not on this specification alone.

These materials are designed to be used in low and medium voltage cable accessories and as such, electrical performance is proven as part of the assembly. Examples of this are described in EN 50393 and IEC 60502-4.

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 60093, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*~~

IEC 60212, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

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

~~IEC 60250, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metric wavelengths*~~

IEC 60455-2:2015, *Resin based reactive compounds used for electrical insulation – Part 2: Methods of test*~~[1]~~

IEC 62631-2-1, *Dielectric and resistive properties of solid insulating materials – Part 2-1: Relative permittivity and dissipation factor – Technical Frequencies (0,1 Hz – 10 MHz) – AC Methods*

IEC 62631-3-1, *Dielectric and resistive properties of solid insulating materials – Part 3-1: Determination of resistive properties (DC methods) – Volume resistance and volume resistivity – General method*

~~[1] Third edition to be published.~~

IEC 62631-3-2, *Dielectric and resistive properties of solid insulating materials – Part 3-2: Determination of resistive properties (DC methods) – Surface resistance and surface resistivity*

ISO 179 (all parts), *Plastics – Determination of Charpy impact properties*

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

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

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

ISO 2137, *Petroleum products and lubricants – Determination of cone penetration of lubricating greases and petrolatum*

ISO 2555, *Plastics — Resins in the liquid state or as emulsions or dispersions — Determination of apparent viscosity ~~by the Brookfield Test~~ using a single cylinder type rotational viscometer method*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1
tendency to crystallization
measurement of the ability of epoxy based resin not to change from a liquid to a solid state at a certain temperature close to water freezing point for a fixed time

3.2
type test
test made on materials or components of a cable accessory in order to demonstrate satisfactory performance characteristics to meet the intended application

~~**3.3**~~
~~**outer protection**~~
~~cured resinous compound to protect the connections from damage by external mechanical forces~~

4 Designation

Resins for cable accessories are classified in categories according to their application as follows (see Table 1):

Table 1 – Categories of resins

~~Voltage Class~~	~~Function~~	~~Characteristic~~
~~Low Voltage (L)~~	~~Outer Protection (OP)~~	~~Cures in presence of water [a] (W)~~
~~Medium Voltage (M)~~	~~Insulation (I)~~	
~~[a] Low foaming during curing when in contact with water as described in the subclause dealing with curing under water in IEC 60455-2.~~		

Voltage class	Mechanical classification	Characteristic
Low voltage (L)	Rigid (R)	Suitable for applications in presence of water [a] (W)
Medium voltage (M)	Soft (S)	
	Gel-like (G)	
[a] Low foaming during curing when in contact with water as described in IEC 60455-2:2015, 5.26.		

~~A resin is identified by a combination of categories.~~

~~For example: Low voltage compound for outer protection: L-OP;~~
~~Low voltage compound for insulation, curing in presence of water: L-I-W;~~
~~Low voltage compound for insulation and mechanical protection: L-OP-I.~~

For the purposes of this document:

– rigid is defined as Shore D > 30, the material has self-supporting properties,
– soft is defined as Shore D ≤ 30 and Shore A ≥ 10,
– gel-like is defined as Shore A < 10.

A resin is identified by a combination of categories, for example:

- low voltage compound – soft: L-S
- low voltage compound – rigid, suitable for application in presence of water: L-R-W

Resins without specific information about application temperature are suitable for applications between 5 °C and 40 °C. Otherwise the application temperature shall be stated by the manufacturer on the packaging.

Tests for type testing are carried out in accordance with each of the resin categories.

Low voltage: 0,6/1,0 (1,2) kV
Medium voltage: 20,8/36 (42) kV

5 Type testing

5.1 General

Tests shall be carried out based on the category of the resins as defined in Table 1. These tests are of such nature that, once successfully completed, they need not to be repeated unless changes are made in the material, component formulation or manufacturing process, which might change the performance characteristics.

5.2 Sampling

Samples for type testing shall be taken from material stored under conditions ~~prescribed~~ specified by the manufacturer. The type testing of resins shall be carried out ~~either~~:

– as a stand-alone test. Samples used for the type test shall be taken from material available as agreed between supplier and user, or

– in combination with an accessory type test. Samples used for the resins type test shall be taken from the same batch as used in the accessory type test. In the event that no material from the same batch is available, then the samples used for the resins type test shall be taken from material available as agreed between supplier and user.

5.3 Preparation and conditioning

5.3.1 General

For all tests, unless otherwise specified, conditioning shall be made in accordance with IEC 60212 using standard atmosphere B.

5.3.2 Individual components prior to mixing

Components (resin and reactive component) shall be individually prepared, conditioned and tested in accordance with the relevant test method as specified in stage 1 of the sequence of tests given in Table 2 to Table 5. Filler, when supplied as a separate item, shall not be tested as a component.

5.3.3 Resin just after mixing (curing stage)

Compounds shall be prepared and mixed according to the supplier's instructions and tested as specified in stage 2 of the sequence of tests specified in Table 2 to Table 5.

5.3.4 Cured resin (original)

Compounds shall be prepared according to the supplier's instructions and cured for 24 h at room temperature unless otherwise specified in the test method referred to in stage 3 of the sequence of tests given in Table 2 to Table 5. The specimens shall be post-cured at (80 ± 2) °C for 24 h unless otherwise specified in the test method, and then cooled in a desiccator for 24 h at room temperature.

NOTE If degassing is needed, it will be indicated in the relevant test method and the conditions for the degassing will also be indicated.

5.3.5 Cured resin after thermal ageing (dry and wet)

Cured resin shall be prepared according to the supplier's instructions and cured for 24 h at room temperature unless otherwise specified in the test method referred to in stage 4 of the sequence of tests given in Table 2 to Table 5. The specimens shall be post-cured at (80 ± 2) °C for 24 h unless otherwise specified in the test method, and then cooled in a desiccator for 24 h at room temperature.

NOTE If degassing is needed, it will be indicated in the relevant test method and the conditions for the degassing will also be indicated.

5.4 Sequence of tests

Tests shall be carried out on the resin in the following four stages, in accordance with Table 2 to Table 5:

stage 1: Reactive components prior to mixing;

stage 2: Resin just after mixing (curing stage);

stage 3: Cured resin (original);

stage 4: Cured resin after heat exposure (dry and wet).

5.5 Test report

The test report shall include the following data:

1) resin category and identification;
2) lot number or identification;
3) 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 mix the compound;
7) copy of the technical data sheet (TDS) and MSDS.

6 Test methods

International test methods are specified within this document where available; for those tests where there is no international test method available or the test method needs some adaptation of conditions, the method or specific conditions are specified in IEC 60455-2.

For special applications, water temperature in Table 2 to Table 5, stage 4-2 (Wet heat resistance), ~~may~~ can be insufficient to ensure the satisfactory performance of the resinous compound. In such cases, upon agreement between manufacturer and user, the compound shall be tested using an increased temperature of 90 °C. The chosen temperature shall be recorded in the test report.

Compliance at 90 °C also includes compliance at 70 °C.

Table 2 – Type tests: test methods and requirements for Polyurethane resins

Number	Property	Test method	Units	Requirement	Remarks
Stage 1 – Reactive components prior to mixing					
1	Viscosity at 5 °C	ISO 2555	Pas	≤ 50	
2	Tendency to crystallization	ISO 4895	-	No turbidity after 7 days	Epoxy resin part only.
Stage 2 – Resins just after mixing (curing stage)					
3	Pot life (0,3 l at 5 °C) Pot life (0,3 l at 40 °C)	IEC 60455-2	min min	< 75 ≥ 5	
4	Curing in presence of water, gas volume Curing in presence of water, physical structure	IEC 60455-2	ml	< 10 No blisters or cracks, small amount of individual bubbles or inclusions acceptable.	For PUR resin type W only. Include picture of cut resin surface with scale in report.
Stage 3 – Cured resins (original)					
5	Density	ISO 1183-1	g/cm^3	Record value	Density should be > 1,05 g/cm^3
6	Impact strength (without notch)	ISO 179	kJ/m^2	≥ 6	No break is also acceptable.
7	Hardness (Shore)	ISO 868		Record value	
8	Tensile strength	ISO 527	MPa	Record value	
9	Elongation at break	ISO 527	%	Record value	
10	Dissipation factor at room temperature [a]	IEC 60250		MI: dissipation factor ≤ 0,1	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
11	Dielectric constant at room temperature [a]	IEC 60250		MI: relative permittivity ≤ 6	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
12	Volume resistivity at room temperature [a]	IEC 60093	Ω cm	MI: ≥ 1×10^{13} LI: ≥ 1×10^{11}	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
[a] According IEC 60212 atmosphere B.					

Stage 4 – Cured resins after heat exposure					
	4-1 Dry heat resistance: 28 days at 120 °C (vented oven) – IEC 60455-2				
13	Mass loss	IEC 60455-2	%	≤ 5	
14	Impact strength (without notch)	ISO 179	kJ/m^2	≥ 4	No break is also acceptable.
	4-2 Wet heat resistance: 28 days at 70 °C [b] in water – IEC 60455-2				
15	Hardness (retention/original)	ISO 868	%	≥ 80	
16	Tensile strength (retention/original)	ISO 527	%	≥ 65	
17	Elongation at break (retention/original)	ISO 527	%	≥ 65	
18	Dielectric strength (resin type LI) Dielectric strength (resin type MI)	IEC 60243-1	kV/mm	≥ 2 ≥ 5	For resin type I only.

[b] See also Clause 6 regarding test at 90 °C.

Number	Property	Test method	Units	Requirement	Remarks
Stage 1 – Reactive components prior to mixing					
1	Viscosity at 5 °C	ISO 2555[b]	Pa · s	≤ 50	Resin only
Stage 2 – Resins just after mixing (curing stage)					
2	Pot life (0,3 l at 5 °C) Pot life (0,3 l at 40 °C)	IEC 60455-2	min min	< 75 ≥ 5	
3	Curing in presence of water, physical structure	IEC 60455-2		No blisters or cracks, small amount of individual bubbles or inclusions acceptable	For PUR resin type W only. See Annex A Include picture of cut resin surface with scale in report
Stage 3 – Cured resins (original)					
4	Density	ISO 1183-1	g/cm^3	>1,05 g/cm^3	Only for category W
5	Impact strength (without notch)	ISO 179 (all parts)	kJ/m^2	≥ 6	No break is also acceptable
6	Hardness (Shore)	ISO 868		For classification purpose	See Clause 4
7	Tensile strength	ISO 527 (all parts)	MPa	Record value	
8	Elongation at break	ISO 527 (all parts)	%	Record value	
9	Dissipation factor at room temperature [a]	IEC 62631-2-1		M: dissipation factor ≤ 0,1	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
10	Dielectric constant at room temperature [a]	IEC 62631-2-1		M: relative permittivity ≤ 6	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
11	Volume resistivity at room temperature [a]	IEC 62631-3-1 and IEC 62631-3-2	Ω cm	M: ≥ 1 × 10^{13} L: ≥ 1 × 10^{11}	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz

[a] According IEC 60212 atmosphere B.

[b] Use spindle 2 min^{-1} and 10 min^{-1} for viscosities up to 4 Pa·s; use spindle 3 min^{-1} and 10 min^{-1} for viscosities > 4 Pa·s up to 10 Pa·s; use spindle 4 min^{-1} and 10 min^{-1} for viscosities > 10 Pa·s up to 20 Pa·s; use spindle 5 min^{-1} and 10 min^{-1} for viscosities > 20 Pa·s up to 40 Pa·s use spindle 7 min^{-1}and 50 min^{-1} for viscosities > 40 Pa·s.

Reading when indication is stable.

Number	Property	Test method	Units	Requirement	Remarks
Stage 4 – Cured resins after heat exposure					
	4-1 Dry heat resistance: 28 days at 120 °C (vented oven) – IEC 60455-2				
12	Mass loss	IEC 60455-2	%	≤ 5	
13	Impact strength (without notch)	ISO 179 (all parts)	kJ/m^2	≥ 4	No break is also acceptable
	4-2 Wet heat resistance: 28 days at 70 °C [c] in water – IEC 60455-2				
14	Hardness (retention/original)	ISO 868	%	≥ 80	
15	Tensile strength (retention/original)	ISO 527 (all parts)	%	≥ 65	
16	Elongation at break (retention/original)	ISO 527 (all parts)	%	≥ 65	
17	Dielectric strength (resin type L) Dielectric strength (resin type M)	IEC 60243-1	kV/mm	≥ 2 ≥ 5	

[c] See also Clause 6 regarding the test at 90 °C.

Table 3 – Type tests: test methods and requirements for Polybutadiene resins

Number	Property	Test method	Units	Requirement	Remarks
Stage 1 – Reactive components prior to mixing					
1	Viscosity at 5 °C	ISO 2555[b]	Pa · s	≤ 50	Viscosity of both components at 5 °C; higher value is accepted when mixing viscosity in stage 2.2 is below 50 Pas
Stage 2 – Resins just after mixing (curing stage)					
2	Pot life (0,3 l at 5 °C) Pot life (0,3 l at 40 °C)	IEC 60455-2	min min	≤ 75 ≥ 5	
Stage 3 – Cured resins (original)					
3	Density	ISO 1183-1	g/cm^3	>1,05 g/cm^3	Only for category W
4	Hardness (Shore)	ISO 868		For classification purpose	See Clause 4
5	Dissipation factor at room temperature [a]	IEC 62631-2-1		M: dissipation factor ≤ 0,1	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
6	Dielectric constant at room temperature [a]	IEC 62631-2-1		MI: relative permittivity ≤ 6	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
7	Volume resistivity at room temperature [a]	IEC 62631-3-1 and IEC 62631-3-2	Ω cm	M: ≥ 1 × 10^{13} L: ≥ 1 × 10^{11}	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
Stage 4 – Cured resins after heat exposure					
	4-1 Dry heat resistance: 28 days at 80 °C (vented oven) – IEC 60455-2				
8	Mass loss	IEC 60455-2	%	≤ 5	
	4-2 Wet heat resistance: 28 days at 70 °C in water – IEC 60455-2				Not relevant

[a] According IEC 60212 atmosphere B.

[b] Use spindle 2 min^{-1} and 10 min^{-1} for viscosities up to 4 Pa·s; use spindle 3 min^{-1} and 10 min^{-1} for viscosities > 4 Pa·s up to 10 Pa·s; use spindle 4 min^{-1} and 10 min^{-1} for viscosities > 10 Pa·s up to 20 Pa·s; use spindle 5 min^{-1} and 10 min^{-1} for viscosities > 20 Pa·s up to 40 Pa·s; use spindle 7 min^{-1} and 50 min^{-1} for viscosities > 40 Pa·s.

Reading when indication is stable.

Table 4 – Type tests: test methods and requirements for Epoxy resins

Number	Property	Test method	Units	Requirement	Remarks
Stage 1 – Reactive components prior to mixing					
1	Viscosity at 5 °C	ISO 2555[b]	Pa · s	≤ 50	Viscosity of both components at 5 °C; higher value is accepted when mixing viscosity in stage 2.3 is below 50 Pas
2	Tendency to crystallization	ISO 4895	-	Keep class a for 10 days	Diameter and height of glass tube may deviate ±10 mm
Stage 2 – Resins just after mixing (curing stage)					
3	Pot life (0,3 l at 5 °C) Pot life (0,3 l at 40 °C)	IEC 60455-2	min min	< 75 ≥ 5	
4	Exotherm peak temperature at 23 °C	IEC 60455-2	max.	≤ 165 °C	
Stage 3 – Cured resins (original)					
5	Density	ISO 1183-1	g/cm^3	>1,05 g/cm^3	Only for category W
6	Impact strength (without notch)	ISO 179 (all parts)	kJ/m^2	≥ 6	No break is also acceptable
7	Hardness (Shore)	ISO 868		For classification purpose	See Clause 4
8	Tensile strength	ISO 527 (all parts)	MPa	Record value	
9	Elongation at break	ISO 527 (all parts)	%	Record value	
10	Dissipation factor at room temperature [a]	IEC 62631-2-1		M: dissipation factor ≤ 0,1	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
11	Dielectric constant at room temperature [a]	IEC 62631-2-1		MI: relative permittivity ≤ 6	
12	Volume resistivity at room temperature [a]	IEC 62631-3-1 and IEC 62631-3-2	Ω cm	M: ≥ 1 × 10^{13} L: ≥ 1 × 10^{11}	

[a] According IEC 60212 atmosphere B.

[b] Use spindle 2 min^{-1}and 10 min^{-1} for viscosities up to 4 Pa·s; use spindle 3 min^{-1} and 10 min^{-1} for viscosities > 4 Pa·s up to 10 Pa·s; use spindle 4 min^{-1} and 10 min^{-1} for viscosities > 10 Pa·s up to 20 Pa·s; use spindle 5 min^{-1} and 10 min^{-1} for viscosities > 20 Pa·s up to 40 Pa·s; use spindle 7 min^{-1} and 50 min^{-1} for viscosities > 40 Pa·s.

Reading when indication is stable.

Number	Property	Test method	Units	Requirement	Remarks
Stage 4 – Cured resins after heat exposure					
	4-1 Dry heat resistance: 28 days at 120 °C (vented oven) – IEC 60455-2				
13	Mass loss	IEC 60455-2	%	≤ 5	
14	Impact strength (without notch)	ISO 179 (all parts)	kJ/m^2	≥ 4	No break is also acceptable
	4-2 Wet heat resistance: 28 days at 70 °C [c] in water – IEC 60455-2				
15	Hardness (retention/original)	ISO 868	%	≥ 80	
16	Tensile strength (retention/original)	ISO 527 (all parts)	%	≥ 65	
17	Elongation at break (retention/original)	ISO 527 (all parts)	%	≥ 65	
18	Dielectric strength (resin type L) Dielectric strength (resin type M)	IEC 60243-1	kV/mm	≥ 2 ≥ 5	

[c] See also Clause 6 regarding the test at 90 °C.

Table 5 – Type tests: test methods and requirements for Silicone resins

Number	Property	Test method	Units	Requirement	Remarks
Stage 1 – Reactive components prior to mixing					
1	Viscosity at 5 °C	ISO 2555[b]	Pa · s	≤ 50	Viscosity of both components at 5 °C
Stage 2 – Resins just after mixing (curing stage)					
2	Pot life (0,3 l at lowest application temperature) Pot life (0,3 l at highest application temperature)	IEC 60455-2	min min	< 75 ≥ 5	
Stage 3 – Cured resins (original)					
3	Density	ISO 1183-1	g/cm^3	> 1,05 g/cm^3	Only for category W
4	Hardness (Shore)	ISO 868		For classification purpose	See Clause 4
5	PEN-hardness	ISO 2137	1/10 mm	Record value	Only if Shore A ≤ 10
6	Dissipation factor at room temperature [a]	IEC 62631-2-1		M: dissipation factor ≤ 0,1	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
7	Dielectric constant at room temperature [a]	IEC 62631-2-1		M: relative permittivity ≤ 6	
8	Volume resistivity at room temperature [a]	IEC 62631-3-1 and IEC 62631-3-2	Ω cm	M: ≥ 1 × 10^{13} L: ≥ 1 × 10^{11}	
Stage 4 – Cured resins after heat exposure					
	4-1 Dry heat resistance: 28 days at 120 °C (vented oven) – IEC 60455-2				
9	Mass loss	IEC 60455-2	%	≤ 5	
	4-2 Wet heat resistance: 28 days at 70 °C in water – IEC 60455-2				Not relevant

[a] According IEC 60212 atmosphere B.

[b] Use spindle 2 min^{-1} and 10 min^{-1} for viscosities up to 4 Pa·s; use spindle 3 min^{-1} and 10 min^{-1} for viscosities > 4 Pa·s up to 10 Pa·s; use spindle 4 min^{-1} and 10 min^{-1} for viscosities > 10 Pa·s up to 20 Pa·s; use spindle 5 min^{-1} and 10 min^{-1} for viscosities > 20 Pa·s up to 40 Pa·s; use spindle 7 min^{-1} and 50 min^{-1} for viscosities > 40 Pa·s.

Reading when indication is stable.

7 Information on supply, packaging, marking and labelling

7.1 Packaging

Packaging shall be sufficient to ensure that any stated shelf life of the reactive components is maintained when stored under specified conditions of temperature and humidity.

7.2 Marking and labelling

7.2.1 General

The following information, in the relevant national language(s), shall be printed or labelled on the resin components packaging and on the accessory kit.

7.2.2 Components

Each individual part of the resin or the reactive compound~~s~~ if packed separately shall be printed or labelled on its packaging with:

1) the supplier's name or logo;
2) the part number or identification;
3) the lot number or production date;
4) the specified storage conditions, if any;
5) the "use before date" (shelf life);
6) the health and safety marking according to relevant EU or national legislation;
7) the mixing and application instructions
8) the resin categories.

7.2.3 Accessory kit

Each accessory kit containing a reactive component shall be printed or labelled on its packaging and shall at least indicate:

1) the specified storage conditions, if any;
2) the "use before date" (shelf life);
3) the health and safety marking according to relevant EU or national legislation.

Annex A
(normative)

Examination grid

Evaluate the concentration and dimension of bubbles created by using an examination grid. The grid measures 45 × 24 mm (width × height) and is made up of 15 cells of dimensions 9 mm × 8 mm (see Figure A.1):

Dimensions in millimetres

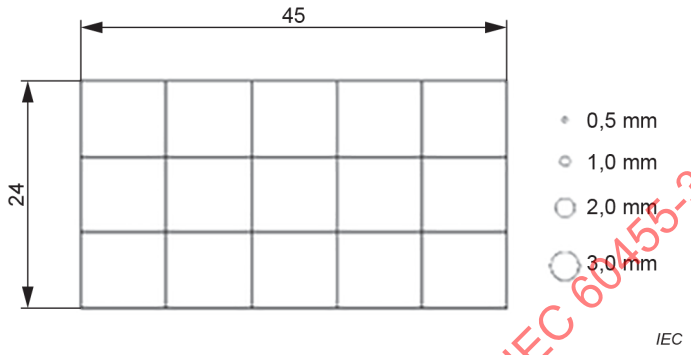


Figure A.1 – Examination grid

Position the grid centrally on the cut surface. To pass the examination no bubbles > 3 mm are allowed and at least 5 cells shall be free of bubbles. Count only bubbles with a diameter ≥ 1 mm (see Figure A.2).

Dimensions in millimetres

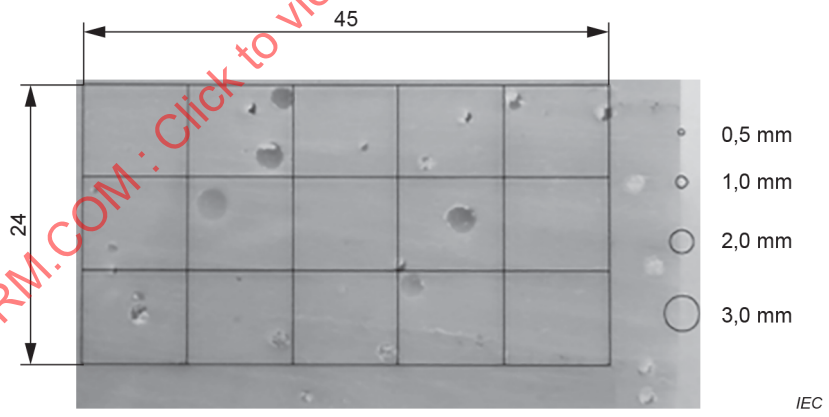


Figure A.2 – Position of examination grid on the specimen

Bibliography

IEC 60455-1, *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 60502-4, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) – Part 4: Test requirements on accessories for cables with rated voltages from 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)*

IEC 61234-2, *Electrical insulating materials – Methods of test for the hydrolytic stability – Part 2: Moulded thermosets*

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

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

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

ISO 7056, *Plastics laboratory ware – Beakers*

EN 50393, *Test methods and requirements for accessories for use on distribution cables of rated voltage 0,6/1,0 (1,2) kV*

HD 629.1, *Test requirements on accessories for use on power cables of rated voltage from 3,6/6(7,2) kV up to 20,8/36(42) kV – Part 1: Cables with extruded insulation*

HD 629.2, *Test requirements on accessories for use on power cables of rated voltage from 3,6/6(7,2) kV up to 20,8/36(42) kV – Part 2: Cables with impregnated paper insulation*

IEC 60455-3-8

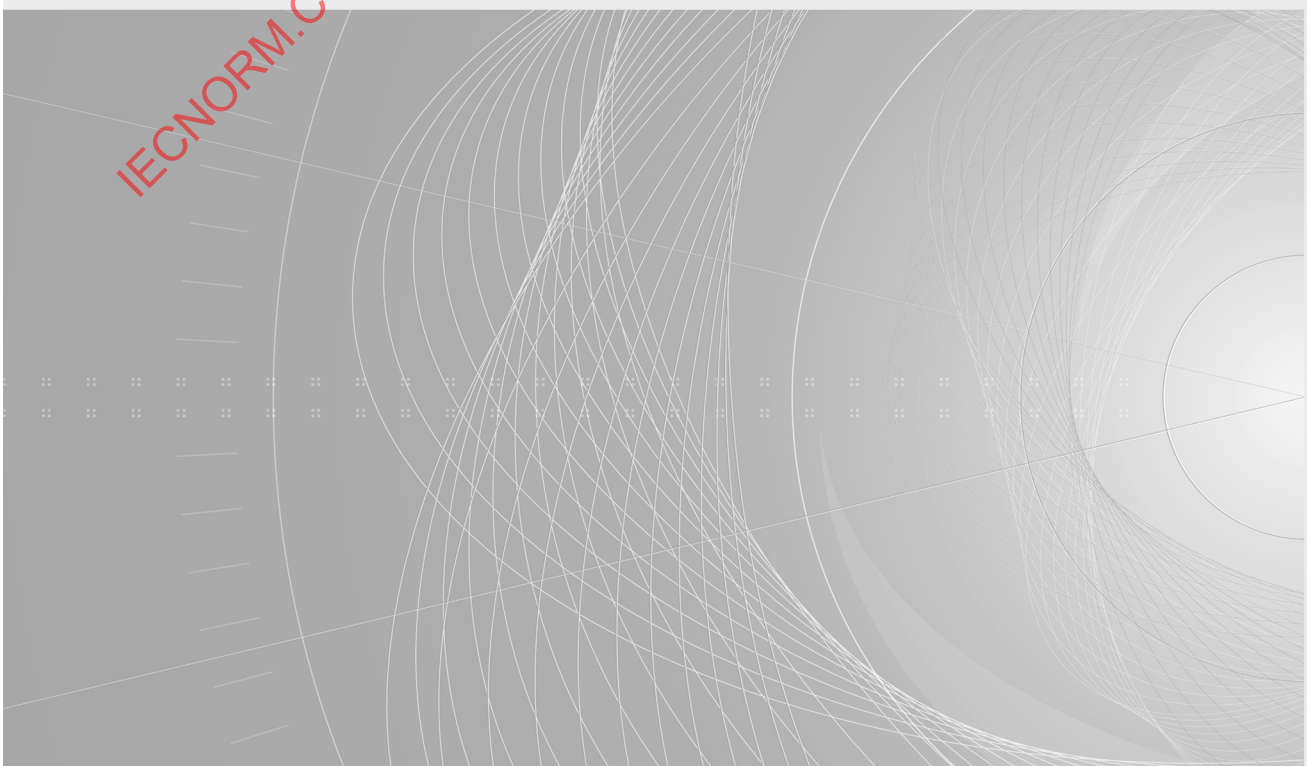
Edition 2.0 2021-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Composés réactifs à base de résines utilisés comme isolants électriques – Partie 3-8: Spécifications pour matériaux particuliers – Résines pour accessoires de câble



IEC 60455-3-8:2021-06(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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RESIN BASED REACTIVE COMPOUNDS USED FOR ELECTRICAL INSULATION –

Part 3-8: Specifications for individual materials – Resins for cable accessories

FOREWORD

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International Standard IEC 60455-3-8 has been prepared by IEC technical committee 15: Solid electrical insulating materials.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

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

a) Clause 1: a link to assemblies according to IEC 60502-4 and EN 50393 was introduced;
b) designation: the categories, especially the mechanical ones, were redefined;
c) type tests: the testing was updated based on the chemical basis of the material;
d) type tests: additional materials were introduced;
e) Annex A: an examination grid was established.

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

FDIS	Report on voting
15/937/FDIS	15/941/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/standardsdev/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 specifications for reactive compounds and their components for electrical insulation. This series consists of three parts:

Part 1: Definitions and general requirements (IEC 60455-1);

Part 2: Methods of test (IEC 60455-2);

Part 3: Specifications for individual materials (IEC 60455-3)

IEC 60455-3-8 is one of the specification sheets comprising Part 3 as follows:

Sheet 8: Resins for cable accessories

RESIN BASED REACTIVE COMPOUNDS USED FOR ELECTRICAL INSULATION –

Part 3-8: Specifications for individual materials – Resins for cable accessories

1 Scope

This part of IEC 60455 gives the requirements for resins for power cable accessories that conform to this specification and meet established levels of performance. However, the selection of a material by a user for a specific application will be based on the actual requirements necessary for adequate performance in that application and not on this specification alone.

These materials are designed to be used in low and medium voltage cable accessories and as such, electrical performance is proven as part of the assembly. Examples of this are described in EN 50393 and IEC 60502-4.

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 60212*, Standard conditions for use prior to and during the testing of solid electrical insulating materials*

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

IEC 60455-2:2015, *Resin based reactive compounds used for electrical insulation – Part 2: Methods of test*

IEC 62631-2-1, *Dielectric and resistive properties of solid insulating materials – Part 2-1: Relative permittivity and dissipation factor – Technical Frequencies (0,1 Hz – 10 MHz) – AC Methods*

IEC 62631-3-1, *Dielectric and resistive properties of solid insulating materials – Part 3-1: Determination of resistive properties (DC methods) – Volume resistance and volume resistivity – General method*

IEC 62631-3-2, *Dielectric and resistive properties of solid insulating materials – Part 3-2: Determination of resistive properties (DC methods) – Surface resistance and surface resistivity*

ISO 179 (all parts), *Plastics – Determination of Charpy impact properties*

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

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

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

ISO 2137, *Petroleum products and lubricants – Determination of cone penetration of lubricating greases and petrolatum*

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

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1
tendency to crystallization
measurement of the ability of epoxy based resin not to change from a liquid to a solid state at a certain temperature close to water freezing point for a fixed time

3.2
type test
test made on materials or components of a cable accessory in order to demonstrate satisfactory performance characteristics to meet the intended application

4 Designation

Resins for cable accessories are classified in categories according to their application as follows (see Table 1):

Table 1 – Categories of resins

Voltage class	Mechanical classification	Characteristic
Low voltage (L)	Rigid (R)	Suitable for applications in presence of water [a] (W)
Medium voltage (M)	Soft (S)	
	Gel-like (**G**)	
[a] Low foaming during curing when in contact with water as described in IEC 60455-2:2015, 5.26.		

For the purposes of this document:

– rigid is defined as Shore D > 30, the material has self-supporting properties,
– soft is defined as Shore D ≤ 30 and Shore A ≥ 10,
– gel-like is defined as Shore A < 10.

A resin is identified by a combination of categories, for example:

- low voltage compound – soft: L-S
- low voltage compound – rigid, suitable for application in presence of water: L-R-W

Resins without specific information about application temperature are suitable for applications between 5 °C and 40 °C. Otherwise the application temperature shall be stated by the manufacturer on the packaging.

Tests for type testing are carried out in accordance with each of the resin categories.

Low voltage: 0,6/1,0 (1,2) kV

Medium voltage: 20,8/36 (42) kV

5 Type testing

5.1 General

Tests shall be carried out based on the category of the resins as defined in Table 1. These tests are of such nature that, once successfully completed, they need not to be repeated unless changes are made in the material, component formulation or manufacturing process, which might change the performance characteristics.

5.2 Sampling

Samples for type testing shall be taken from material stored under conditions specified by the manufacturer. The type testing of resins shall be carried out:

– as a stand-alone test. Samples used for the type test shall be taken from material available as agreed between supplier and user, or

– in combination with an accessory type test. Samples used for the resins type test shall be taken from the same batch as used in the accessory type test. In the event that no material from the same batch is available, then the samples used for the resins type test shall be taken from material available as agreed between supplier and user.

5.3 Preparation and conditioning

5.3.1 General

For all tests, unless otherwise specified, conditioning shall be made in accordance with IEC 60212 using standard atmosphere B.

5.3.2 Individual components prior to mixing

Components (resin and reactive component) shall be individually prepared, conditioned and tested in accordance with the relevant test method as specified in stage 1 of the sequence of tests given in Table 2 to Table 5. Filler, when supplied as a separate item, shall not be tested as a component

5.3.3 Resin just after mixing (curing stage)

Compounds shall be prepared and mixed according to the supplier's instructions and tested as specified in stage 2 of the sequence of tests specified in Table 2 to Table 5.

5.3.4 Cured resin (original)

Compounds shall be prepared according to the supplier's instructions and cured for 24 h at room temperature unless otherwise specified in the test method referred to in stage 3 of the sequence of tests given in Table 2 to Table 5. The specimens shall be post-cured at (80 ± 2) °C for 24 h unless otherwise specified in the test method, and then cooled in a desiccator for 24 h at room temperature.

NOTE If degassing is needed, it will be indicated in the relevant test method and the conditions for the degassing will also be indicated.

5.3.5 Cured resin after thermal ageing (dry and wet)

Cured resin shall be prepared according to the supplier's instructions and cured for 24 h at room temperature unless otherwise specified in the test method referred to in stage 4 of the sequence of tests given in Table 2 to Table 5. The specimens shall be post-cured at (80 ± 2) °C for 24 h unless otherwise specified in the test method, and then cooled in a desiccator for 24 h at room temperature.

NOTE If degassing is needed, it will be indicated in the relevant test method and the conditions for the degassing will also be indicated.

5.4 Sequence of tests

Tests shall be carried out on the resin in the following four stages, in accordance with Table 2 to Table 5:

stage 1: Reactive components prior to mixing;

stage 2: Resin just after mixing (curing stage);

stage 3: Cured resin (original);

stage 4: Cured resin after heat exposure (dry and wet).

5.5 Test report

The test report shall include the following data:

1) resin category and identification;
2) lot number or identification;
3) 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 mix the compound;
7) copy of the technical data sheet (TDS) and MSDS.

6 Test methods

International test methods are specified within this document where available; for those tests where there is no international test method available or the test method needs some adaptation of conditions, the method or specific conditions are specified in IEC 60455-2.

For special applications, water temperature in Table 2 to Table 5, stage 4-2 (Wet heat resistance), can be insufficient to ensure the satisfactory performance of the resinous compound. In such cases, upon agreement between manufacturer and user, the compound shall be tested using an increased temperature of 90 °C. The chosen temperature shall be recorded in the test report.

Compliance at 90 °C also includes compliance at 70 °C.

Table 2 – Type tests: test methods and requirements for Polyurethane resins

Number	Property	Test method	Units	Requirement	Remarks
Stage 1 – Reactive components prior to mixing					
1	Viscosity at 5 °C	ISO 2555[b]	Pa · s	≤ 50	Resin only
Stage 2 – Resins just after mixing (curing stage)					
2	Pot life (0,3 l at 5 °C) Pot life (0,3 l at 40 °C)	IEC 60455-2	min min	< 75 ≥ 5	
3	Curing in presence of water, physical structure	IEC 60455-2		No blisters or cracks, small amount of individual bubbles or inclusions acceptable	For PUR resin type W only. See Annex A Include picture of cut resin surface with scale in report
Stage 3 – Cured resins (original)					
4	Density	ISO 1183-1	g/cm^3	>1,05 g/cm^3	Only for category W
5	Impact strength (without notch)	ISO 179 (all parts)	kJ/m^2	≥ 6	No break is also acceptable
6	Hardness (Shore)	ISO 868		For classification purpose	See Clause 4
7	Tensile strength	ISO 527 (all parts)	MPa	Record value	
8	Elongation at break	ISO 527 (all parts)	%	Record value	
9	Dissipation factor at room temperature [a]	IEC 62631-2-1		M: dissipation factor ≤ 0,1	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
10	Dielectric constant at room temperature [a]	IEC 62631-2-1		M: relative permittivity ≤ 6	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
11	Volume resistivity at room temperature [a]	IIEC 62631-3-1 and IEC 62631-3-2	Ω cm	M: ≥ 1 × 10^{13} L: ≥ 1 × 10^{11}	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz

[a] According IEC 60212 atmosphere B.

[b] Use spindle 2 min^{-1} and 10 min^{-1} for viscosities up to 4 Pa·s; use spindle 3 min^{-1} and 10 min^{-1} for viscosities > 4 Pa·s up to 10 Pa·s; use spindle 4 min^{-1} and 10 min^{-1} for viscosities > 10 Pa·s up to 20 Pa·s; use spindle 5 min^{-1} and 10 min^{-1} for viscosities > 20 Pa·s up to 40 Pa·s use spindle 7 min^{-1}and 50 min^{-1} for viscosities > 40 Pa·s.

Reading when indication is stable.

Number	Property	Test method	Units	Requirement	Remarks
Stage 4 – Cured resins after heat exposure					
	4-1 Dry heat resistance: 28 days at 120 °C (vented oven) – IEC 60455-2				
12	Mass loss	IEC 60455-2	%	≤ 5	
13	Impact strength (without notch)	ISO 179 (all parts)	kJ/m^2	≥ 4	No break is also acceptable
	4-2 Wet heat resistance: 28 days at 70 °C [c] in water – IEC 60455-2				
14	Hardness (retention/original)	ISO 868	%	≥ 80	
15	Tensile strength (retention/original)	ISO 527 (all parts)	%	≥ 65	
16	Elongation at break (retention/original)	ISO 527 (all parts)	%	≥ 65	
17	Dielectric strength (resin type L) Dielectric strength (resin type M)	IEC 60243-1	kV/mm	≥ 2 ≥ 5	

[c] See also Clause 6 regarding the test at 90 °C.

Table 3 – Type tests: test methods and requirements for Polybutadiene resins

Number	Property	Test method	Units	Requirement	Remarks
Stage 1 – Reactive components prior to mixing					
1	Viscosity at 5 °C	ISO 2555[b]	Pa · s	≤ 50	Viscosity of both components at 5 °C; higher value is accepted when mixing viscosity in stage 2.2 is below 50 Pas
Stage 2 – Resins just after mixing (curing stage)					
2	Pot life (0,3 l at 5 °C) Pot life (0,3 l at 40 °C)	IEC 60455-2	min min	≤ 75 ≥ 5	
Stage 3 – Cured resins (original)					
3	Density	ISO 1183-1	g/cm^3	>1,05 g/cm^3	Only for category W
4	Hardness (Shore)	ISO 868		For classification purpose	See Clause 4
5	Dissipation factor at room temperature [a]	IEC 62631-2-1		M: dissipation factor ≤ 0,1	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
6	Dielectric constant at room temperature [a]	IEC 62631-2-1		MI: relative permittivity ≤ 6	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
7	Volume resistivity at room temperature [a]	IEC 62631-3-1 and IEC 62631-3-2	Ω cm	M: ≥ 1 × 10^{13} L: ≥ 1 × 10^{11}	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
Stage 4 – Cured resins after heat exposure					
	4-1 Dry heat resistance: 28 days at 80 °C (vented oven) – IEC 60455-2				
8	Mass loss	IEC 60455-2	%	≤ 5	
	4-2 Wet heat resistance: 28 days at 70 °C in water – IEC 60455-2				Not relevant

[a] According IEC 60212 atmosphere B.

[b] Use spindle 2 min^{-1} and 10 min^{-1} for viscosities up to 4 Pa·s; use spindle 3 min^{-1} and 10 min^{-1} for viscosities > 4 Pa·s up to 10 Pa·s; use spindle 4 min^{-1} and 10 min^{-1} for viscosities > 10 Pa·s up to 20 Pa·s; use spindle 5 min^{-1} and 10 min^{-1} for viscosities > 20 Pa·s up to 40 Pa·s; use spindle 7 min^{-1} and 50 min^{-1} for viscosities > 40 Pa·s.

Reading when indication is stable.

Table 4 – Type tests: test methods and requirements for Epoxy resins

Number	Property	Test method	Units	Requirement	Remarks
Stage 1 – Reactive components prior to mixing					
1	Viscosity at 5 °C	ISO 2555[b]	Pa · s	≤ 50	Viscosity of both components at 5 °C; higher value is accepted when mixing viscosity in stage 2.3 is below 50 Pas
2	Tendency to crystallization	ISO 4895	-	Keep class a for 10 days	Diameter and height of glass tube may deviate ±10 mm
Stage 2 – Resins just after mixing (curing stage)					
3	Pot life (0,3 l at 5 °C) Pot life (0,3 l at 40 °C)	IEC 60455-2	min min	< 75 ≥ 5	
4	Exotherm peak temperature at 23 °C	IEC 60455-2	max.	≤ 165 °C	
Stage 3 – Cured resins (original)					
5	Density	ISO 1183-1	g/cm^3	>1,05 g/cm^3	Only for category W
6	Impact strength (without notch)	ISO 179 (all parts)	kJ/m^2	≥ 6	No break is also acceptable
7	Hardness (Shore)	ISO 868		For classification purpose	See Clause 4
8	Tensile strength	ISO 527 (all parts)	MPa	Record value	
9	Elongation at break	ISO 527 (all parts)	%	Record value	
10	Dissipation factor at room temperature [a]	IEC 62631-2-1		M: dissipation factor ≤ 0,1	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
11	Dielectric constant at room temperature [a]	IEC 62631-2-1		MI: relative permittivity ≤ 6	
12	Volume resistivity at room temperature [a]	IEC 62631-3-1 and IEC 62631-3-2	Ω cm	M: ≥ 1 × 10^{13} L: ≥ 1 × 10^{11}	

[a] According IEC 60212 atmosphere B.

[b] Use spindle 2 min^{-1}and 10 min^{-1} for viscosities up to 4 Pa·s; use spindle 3 min^{-1} and 10 min^{-1} for viscosities > 4 Pa·s up to 10 Pa·s; use spindle 4 min^{-1} and 10 min^{-1} for viscosities > 10 Pa·s up to 20 Pa·s; use spindle 5 min^{-1} and 10 min^{-1} for viscosities > 20 Pa·s up to 40 Pa·s; use spindle 7 min^{-1} and 50 min^{-1} for viscosities > 40 Pa·s.

Reading when indication is stable.

Number	Property	Test method	Units	Requirement	Remarks
Stage 4 – Cured resins after heat exposure					
	4-1 Dry heat resistance: 28 days at 120 °C (vented oven) – IEC 60455-2				
13	Mass loss	IEC 60455-2	%	≤ 5	
14	Impact strength (without notch)	ISO 179 (all parts)	kJ/m^2	≥ 4	No break is also acceptable
	4-2 Wet heat resistance: 28 days at 70 °C [c] in water – IEC 60455-2				
15	Hardness (retention/original)	ISO 868	%	≥ 80	
16	Tensile strength (retention/original)	ISO 527 (all parts)	%	≥ 65	
17	Elongation at break (retention/original)	ISO 527 (all parts)	%	≥ 65	
18	Dielectric strength (resin type L) Dielectric strength (resin type M)	IEC 60243-1	kV/mm	≥ 2 ≥ 5	

[c] See also Clause 6 regarding the test at 90 °C.

Table 5 – Type tests: test methods and requirements for Silicone resins

Number	Property	Test method	Units	Requirement	Remarks
Stage 1 – Reactive components prior to mixing					
1	Viscosity at 5 °C	ISO 2555[b]	Pa · s	≤ 50	Viscosity of both components at 5 °C
Stage 2 – Resins just after mixing (curing stage)					
2	Pot life (0,3 l at lowest application temperature) Pot life (0,3 l at highest application temperature)	IEC 60455-2	min min	< 75 ≥ 5	
Stage 3 – Cured resins (original)					
3	Density	ISO 1183-1	g/cm^3	> 1,05 g/cm^3	Only for category W
4	Hardness (Shore)	ISO 868		For classification purpose	See Clause 4
5	PEN-hardness	ISO 2137	1/10 mm	Record value	Only if Shore A ≤ 10
6	Dissipation factor at room temperature [a]	IEC 62631-2-1		M: dissipation factor ≤ 0,1	Using conductive silver varnish as electrode material Using 500 V/mm at 50 Hz
7	Dielectric constant at room temperature [a]	IEC 62631-2-1		M: relative permittivity ≤ 6	
8	Volume resistivity at room temperature [a]	IEC 62631-3-1 and IEC 62631-3-2	Ω cm	M: ≥ 1 × 10^{13} L: ≥ 1 × 10^{11}	
Stage 4 – Cured resins after heat exposure					
	4-1 Dry heat resistance: 28 days at 120 °C (vented oven) – IEC 60455-2				
9	Mass loss	IEC 60455-2	%	≤ 5	
	4-2 Wet heat resistance: 28 days at 70 °C in water – IEC 60455-2				Not relevant

[a] According IEC 60212 atmosphere B.

[b] Use spindle 2 min^{-1} and 10 min^{-1} for viscosities up to 4 Pa·s; use spindle 3 min^{-1} and 10 min^{-1} for viscosities > 4 Pa·s up to 10 Pa·s; use spindle 4 min^{-1} and 10 min^{-1} for viscosities > 10 Pa·s up to 20 Pa·s; use spindle 5 min^{-1} and 10 min^{-1} for viscosities > 20 Pa·s up to 40 Pa·s; use spindle 7 min^{-1} and 50 min^{-1} for viscosities > 40 Pa·s.

Reading when indication is stable.

7 Information on supply, packaging, marking and labelling

7.1 Packaging

Packaging shall be sufficient to ensure that any stated shelf life of the reactive components is maintained when stored under specified conditions of temperature and humidity.

7.2 Marking and labelling

7.2.1 General

The following information, in the relevant national language(s), shall be printed or labelled on the resin components packaging and on the accessory kit.

7.2.2 Components

Each individual part of the resin or the reactive compound if packed separately shall be printed or labelled on its packaging with:

1) the supplier's name or logo;
2) the part number or identification;
3) the lot number or production date;
4) the specified storage conditions, if any;
5) the "use before date" (shelf life);
6) the health and safety marking according to relevant EU or national legislation;
7) the mixing and application instructions
8) the resin categories.

7.2.3 Accessory kit

Each accessory kit containing a reactive component shall be printed or labelled on its packaging and shall at least indicate:

1) the specified storage conditions, if any;
2) the "use before date" (shelf life);
3) the health and safety marking according to relevant EU or national legislation.

Annex A
(normative)

Examination grid

Evaluate the concentration and dimension of bubbles created by using an examination grid. The grid measures 45 × 24 mm (width × height) and is made up of 15 cells of dimensions 9 mm × 8 mm (see Figure A.1):

Dimensions in millimetres

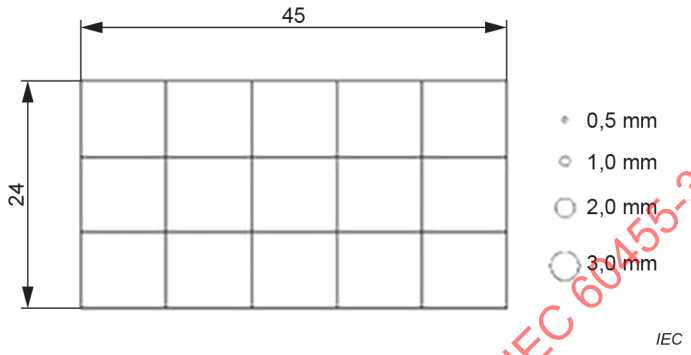

Figure A.1 – Examination grid

Position the grid centrally on the cut surface. To pass the examination no bubbles > 3 mm are allowed and at least 5 cells shall be free of bubbles. Count only bubbles with a diameter ≥ 1 mm (see Figure A.2).

Dimensions in millimetres

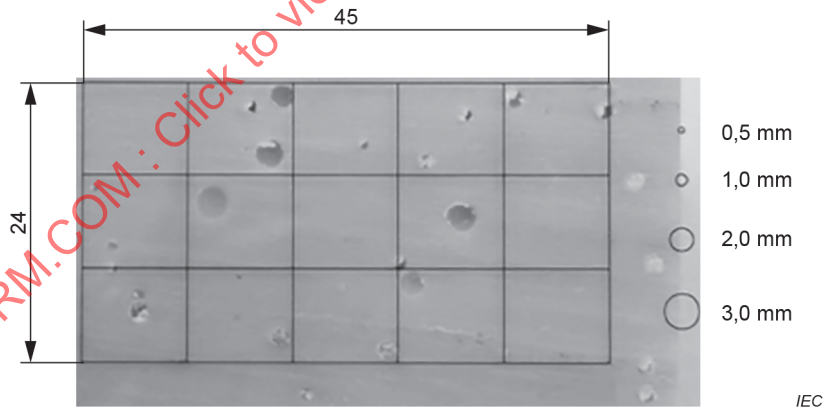

Figure A.2 – Position of examination grid on the specimen

Bibliography

IEC 60455-1, *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 60502-4, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) – Part 4: Test requirements on accessories for cables with rated voltages from 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)*

IEC 61234-2, *Electrical insulating materials – Methods of test for the hydrolytic stability – Part 2: Moulded thermosets*

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

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

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

ISO 7056, *Plastics laboratory ware – Beakers*

EN 50393, *Test methods and requirements for accessories for use on distribution cables of rated voltage 0,6/1,0 (1,2) kV*

HD 629.1, *Test requirements on accessories for use on power cables of rated voltage from 3,6/6(7,2) kV up to 20,8/36(42) kV – Part 1: Cables with extruded insulation*

HD 629.2, *Test requirements on accessories for use on power cables of rated voltage from 3,6/6(7,2) kV up to 20,8/36(42) kV – Part 2: Cables with impregnated paper insulation*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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COMPOSÉS RÉACTIFS À BASE DE RÉSINES UTILISÉS COMME ISOLANTS ÉLECTRIQUES –

Partie 3-8: Spécifications pour matériaux particuliers – Résines pour accessoires de câble

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La Norme internationale IEC 60455-3-8 a été établie par le comité d'études 15 de l'IEC. Matériaux isolants électriques solides

Cette deuxième édition annule et remplace la première édition parue en 2013. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) Article 1: un lien pour les assemblages conformément à l'IEC 60502-4 et à l'EN 50393 a été ajouté;
a) désignation: les catégories, en particulier celles relatives à la mécanique, ont été redéfinies;

b) essais de type: l'essai a été mis à jour en fonction de l'origine chimique du matériau;

c) essais de type: des matériaux supplémentaires ont été ajoutés;

d) Annexe A: une grille d'évaluation a été créée.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
15/937/FDIS	15/941/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Le présent document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous at www.iec.ch/standardsdev/publications.

Une liste de toutes les parties de la série IEC 60455, publiée sous le titre général *Composés réactifs à base de résines utilisés comme isolants électriques*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu du présent document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
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- amendé.

INTRODUCTION

La présente partie de l'IEC 60455 fait partie d'une série traitant de spécifications relatives aux composés réactifs et à leurs composants utilisés comme isolants électriques. La série est constituée de trois parties:

Partie 1: Définitions et prescriptions générales (IEC 60455-1);

Partie 2: Méthodes d'essai (IEC 60455-2);

Partie 3: Spécifications pour matériaux particuliers (IEC 60455-3).

L'IEC 60455-3-8 est l'une des feuilles de spécification formant la Partie 3, comme suit:

Feuille 8: Résines pour accessoires de câble

COMPOSÉS RÉACTIFS À BASE DE RÉSINES UTILISÉS COMME ISOLANTS ÉLECTRIQUES –

Partie 3-8: Spécifications pour matériaux particuliers – Résines pour accessoires de câble

1 Domaine d'application

La présente partie de l'IEC 60455 contient les exigences relatives aux résines pour accessoires de câble de puissance conformes à la présente spécification et satisfaisant aux niveaux de performances établis. Cependant, le choix d'un matériau, par un utilisateur, pour une application spécifique sera fondé sur les exigences réelles nécessaires pour une performance adéquate de cette application, et non fondé sur cette seule spécification.

Ces matériaux sont conçus pour être utilisés avec des accessoires de câbles à basse et moyenne tension et, de fait, les performances électriques sont attestées en tant que partie intégrante de l'assemblage. Des exemples sont fournis dans l'EN 50393 et l'IEC 60502-4.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60212*, Conditions normales à observer avant et pendant les essais de matériaux isolants électriques solides*

IEC 60243-1, *Rigidité diélectrique des matériaux isolants – Méthodes d'essai – Partie 1: Essais aux fréquences industrielles*

IEC 60455-2:2015, *Composés réactifs à base de résine utilisés comme isolants électriques – Partie 2: Méthodes d'essai*

IEC 62631-2-1, *Propriétés diélectriques et résistives des matériaux isolants solides – Partie 2-1: Permittivité relative et facteur de dissipation – Fréquences techniques (0,1 Hz à 10 MHz) – Méthodes en courant alternatif*

IEC 62631-3-1, *Propriétés diélectriques et résistives des matériaux isolants solides – Partie 3-1: Détermination des propriétés résistives (méthodes en courant continu) – Résistance transversale et résistivité transversale – Méthode générale*

IEC 62631-3-2, *Propriétés diélectriques et résistives des matériaux isolants solides – Partie 3-2: Détermination des propriétés résistives (méthodes en courant continu) – Résistance superficielle et résistivité superficielle*

ISO 179 (toutes parties), *Plastiques – Détermination des caractéristiques au choc Charpy*

ISO 527 (toutes parties), *Plastiques – Détermination des propriétés en traction*

ISO 868, *Plastiques et ébonite – Détermination de la dureté par la pénétration au moyen d'un duromètre (dureté Shore)*

ISO 1183-1, *Plastiques – Méthodes de détermination de la masse volumique des plastiques non alvéolaires – Partie 1: Méthode par immersion, méthode du pycnomètre en milieu liquide et méthode par titrage*

ISO 2137, *Produits pétroliers et lubrifiants – Détermination de la pénétrabilité au cône des graisses lubrifiantes et des pétrolatums*

ISO 2555, *Plastiques – Résines à l'état liquide ou en émulsions ou dispersions – Détermination de la viscosité apparente par la méthode du viscosimètre rotatif de type à un cylindre*

ISO 4895, *Plastiques – Résines époxydes liquides – Détermination de la tendance à la cristallisation*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
tendance à la cristallisation
mesurage de la capacité de la résine époxyde à ne pas passer d'un état liquide à un état solide à une certaine température proche du point de gel de l'eau pendant une durée donnée

3.2
essai de type
essai réalisé sur des matériaux ou des composants d'un accessoire de câble, afin de démontrer que leurs caractéristiques de performances satisfont à l'application prévue

4 Désignation

Les résines pour accessoires de câble sont classées par catégories en fonction de leur application comme suit (voir le Tableau 1):

Tableau 1 – Catégories de résines

Classe de tension	Classification mécanique	Caractéristique
Basse tension (L)	Rigide (R)	Adapté à des applications en présence d'eau a (W)
Moyenne tension (M)	Souple (**S**)	
	Gélifié (**G**)	
[a] Faible moussage au cours du durcissement lors d'un contact avec de l'eau tel que le décrit l'IEC 60455-2:2015, 5.26		

Pour les besoins du présent document :

– "rigide" correspond à une dureté Shore D > 30, le matériau présente des propriétés autonomes;
– "souple" correspond à une dureté Shore D ≤ 30 à une dureté Shore A ≥ 10;
– "gélifié" correspond à une dureté Shore A < 10.

Une résine est identifiée par une combinaison de catégories, par exemple:

- composé à basse tension – souple: L-S;
- composé à basse tension – rigide, adapté à une application en présence d'eau: L-R-W.

Les résines qui ne sont pas fournies avec des informations spécifiques relatives à la température d'application sont adaptées à des applications entre 5 °C et 40 °C. Dans le cas contraire, la température d'application doit être définie par le fabricant sur l'emballage.

Les essais pour les essais de type sont effectués conformément à la catégorie de chaque résine.

Basse tension: 0,6/1,0 (1,2) kV

Moyenne tension: 20,8/36 (42) kV

5 Essais de type

5.1 Généralités

Les essais doivent être réalisés en fonction des catégories de résines telles que définies dans le Tableau 1. Ces essais sont de telle nature que, lorsqu'ils sont terminés, il n'est pas nécessaire de les effectuer à nouveau à moins que le matériau, la formulation du composant ou le procédé de fabrication n'aient été modifiés, ce qui pourrait entraîner des modifications des caractéristiques de performances.

5.2 Échantillonnage

Les échantillons servant aux essais de type doivent provenir des matériaux stockés dans les conditions définies par le fabricant. Les essais de type des résines doivent être effectués:

– sous forme d'essai individuel. Les échantillons utilisés pour l'essai de type doivent provenir des matériaux disponibles, comme convenu entre le fournisseur et l'utilisateur; ou

– par combinaison avec un essai de type d'accessoire. Les échantillons utilisés pour l'essai de type de résine doivent provenir du même lot que celui utilisé pour l'essai de type d'accessoire. Dans l'éventualité où aucun matériau provenant du même lot n'est disponible, les échantillons utilisés pour l'essai de type de résine doivent provenir des matériaux disponibles, comme convenu entre le fournisseur et l'utilisateur.

5.3 Préparation et conditionnement

5.3.1 Généralités

Pour tous les essais, sauf spécification contraire, le conditionnement doit être effectué conformément à l'IEC 60212 en atmosphère normale de type B.

5.3.2 Composants individuels avant mélange

Les composants (résine et composant réactif) doivent être préparés, conditionnés et soumis à l'essai séparément, en conformité avec la méthode d'essai adéquate, tel que cela est spécifié à l'étape 1 de la séquence d'essais indiquée du Tableau 2 au Tableau 5. Lorsqu'elle est fournie séparément, la charge ne doit pas être soumise à l'essai en tant que composant.

5.3.3 Résine juste après mélange (étape de durcissement)

Les composés doivent être préparés et mélangés conformément aux instructions du fournisseur et soumis à l'essai tel que cela est spécifié à l'étape 2 de la séquence d'essais indiquée du Tableau 2 au Tableau 5.

5.3.4 Résine durcie (originale)

Les composés doivent être préparés conformément aux instructions du fournisseur et durcis pendant 24 h à température ambiante sauf spécification contraire dans la méthode d'essai mentionnée à l'étape 3 de la séquence d'essais indiquée du Tableau 2 au Tableau 5. Les éprouvettes doivent être post-durcies à (80 ± 2) °C pendant 24 h sauf spécification contraire dans la méthode d'essai, puis refroidies dans un dessiccateur pendant 24 h à température ambiante.

NOTE Si un dégazage est nécessaire, il est indiqué dans la méthode d'essai concernée et les conditions nécessaires pour le réaliser sont également indiquées.

5.3.5 Résine durcie après vieillissement thermique (sec et humide)

La résine durcie doit être préparée conformément aux instructions du fournisseur et durcie pendant 24 h à température ambiante, sauf spécification contraire dans la méthode d'essai mentionnée à l'étape 4 de la séquence d'essais indiquée du Tableau 2 au Tableau 5. Les éprouvettes doivent être post-durcies à (80 ± 2) °C pendant 24 h sauf spécification contraire dans la méthode d'essai, puis refroidies dans un dessiccateur pendant 24 h à température ambiante.

NOTE Si un dégazage est nécessaire, il est indiqué dans la méthode d'essai concernée et les conditions nécessaires pour le réaliser sont également indiquées.

5.4 Séquence d'essais

Les essais réalisés sur la résine doivent suivre les quatre étapes ci-dessous, conformément aux spécifications du Tableau 2 au Tableau 5:

étape 1: Composants réactifs avant mélange;

étape 2: Résine juste après mélange (étape de durcissement);

étape 3: Résine durcie (originale);

étape 4: Résine durcie après exposition à la chaleur (sèche et humide).

5.5 Rapport d'essai

Le rapport d'essai doit comporter les données suivantes:

1) la catégorie et l'identification de la résine;
2) le numéro ou l'identification du lot;
3) le marquage et l'étiquetage conformément à la fiche de données de sécurité;
4) les résultats d'essai;
5) les principaux paramètres de l'essai, y compris le conditionnement et l'étalonnage le cas échéant;
6) les conditions de traitement mises en œuvre pour mélanger le composé;
7) une copie de la fiche de données techniques et de la fiche de données de sécurité.

6 Méthodes d'essai

Si elles sont disponibles, des méthodes internationales d'essai sont indiquées dans le présent document. Concernant les essais pour lesquels il n'existe aucune méthode internationale d'essai ou pour lesquels il est nécessaire que la méthode d'essai fasse l'objet d'adaptations des conditions, la méthode ou les conditions spécifiques sont décrites dans l'IEC 60455-2.

Pour les applications particulières, la température de l'eau indiquée du Tableau 2 au Tableau 5, étape 4-2 (Résistance à la chaleur humide), peut s'avérer insuffisante pour garantir l'obtention de performances satisfaisantes du composé résineux. Dans de telles situations, et sur accord entre le fabricant et l'utilisateur, le composé doit être soumis à l'essai à une température supérieure de 90 °C. La température sélectionnée doit être enregistrée dans le rapport d'essai.