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Electrical insulation systems (EIS) — Thermal evaluation of combined liquid and solid components

Part 3: Hermetic motor-compressors

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National foreword

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Electrical insulation systems (EIS) – Thermal evaluation of combined liquid and solid components – Part 3: Hermetic motor-compressors

Systèmes d'isolation électrique (SIE) – Évaluation thermique de composants liquides et solides combinés – Partie 3: Motocompresseurs hermétiques

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICAL INSULATION SYSTEMS (EIS) – THERMAL EVALUATION OF COMBINED LIQUID AND SOLID COMPONENTS –

Part 3: Hermetic motor-compressors

FOREWORD

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Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62332-3, which is a Technical Specification, has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

The text of this Technical Specification is based on the following documents:

Enquiry draft	Report on voting
112/353/DTS	112/362/RVC

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62332 series, published under the general title *Electrical insulation systems (EIS) – Thermal evaluation of combined liquid and solid components*, can be found on the IEC website.

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

- transformed into an International Standard,
- 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- withdrawn,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 62332, which is a Technical Specification, describes a method for the thermal evaluation of electrical insulation systems (EIS) for electrotechnical products with combined liquid and solid components. IEC TS 62332-1 covers general test requirements. IEC TS 62332-2 covers a simplified test method which can be used as a screening test prior to conducting IEC TS 62332-1 testing or can be used as a quality control test to evaluate minor product changes. This part of IEC 62332 covers the evaluation and qualification of electrical insulation materials (EIM) and EIS which are applied to motor-compressors for the refrigerator or air conditioner. This document contains the evaluation items which are important to maintain the equipment performances in the refrigerator oil and refrigerant at high temperature and high pressure.

This document has been prepared in conjunction with IEC 60335-2-34.

IEC TS 62332-3 is applicable to EIM and EIS evaluation for hermetic motor-compressors which are applied to the refrigerator and the air conditioner. The main procedures consist in the evaluation of EIM and EIS endurance for refigerator and oil at high temperature and high pressure. It describes how to evaluate the mechanical, thermal and chemical degradation of the performances of EIM which have deep relation to keep the sound condition of the equipment.

This simplified Technical Specification provides a test method for sealed tube testing. The sealed tube should contain all the primary EIM elements in relative component ratios which compare with the actual electrotechnical device.

ELECTRICAL INSULATION SYSTEMS (EIS) – THERMAL EVALUATION OF COMBINED LIQUID AND SOLID COMPONENTS –

Part 3: Hermetic motor-compressors

1 Scope

This part of IEC 62332, which is a Technical Specification, is applicable to EIM and EIS containing solid and liquid components where the refrigerant, oil and thermal stresses are the dominant ageing factor, without restriction to voltage class.

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 60216-1, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-3, *Electrical insulating materials – Thermal endurance properties – Part 3: Instructions for calculating thermal endurance characteristics*

IEC 60216-4-1:2006, *Electrical insulating materials – Thermal endurance properties – Part 4-1: Ageing ovens – Single-chamber ovens*

IEC 60216-5, *Electrical insulating materials – Thermal endurance properties – Part 5: Determination of relative thermal endurance index (RTE) of an insulating material*

IEC 60247, *Insulating liquids – Measurement of relative permittivity, dielectric dissipation factor (tan δ) and d.c. resistivity*

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 metre wavelengths*

IEC 60317-0-1, *Specifications for particular types of winding wires – Part 0-1: General requirements – Enamelled round copper wire*

IEC 60505, *Evaluation and qualification of electrical insulation systems*

IEC 60674-2, *Specification for plastic films for electrical purposes. Part 2: Methods of test*

IEC 60684-2, *Flexible insulating sleeving – Part 2: Methods of test*

IEC 60851-5, *Winding wires – Test methods – Part 5: Electrical properties*

IEC 61857-1:2008, *Electrical insulation systems– Procedures for thermal evaluation – Part 1: General requirements – Low voltage*

IEC 61857-21:2009, *Electrical insulation systems – Procedures for thermal evaluation – Part 21: Specific requirements for general-purpose models – Wire-wound applications*

IEC 62021 (all parts), *Insulating liquids – Determination of acidity*

ISO 178, *Plastics – Determination of flexural properties*

ASTM D4603, *Standard Test Method for Determining Inherent Viscosity of Poly(Ethylene Terephthalate) (PET) by Glass Capillary Viscometer*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60505, as well as the following 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
acidity
quantity of base, expressed in milligrams of potassium hydroxide per gram of sample, required to titrate potentiometrically or colourimetrically a test portion in a specified solvent to the end point

[SOURCE: IEC 62021-3: 2014, 3.1]

3.2
breakdown voltage
voltage at which a specimen suffers destructive discharges under the prescribed test conditions

Note 1 to entry: It is used in tests with continuously rising voltage.

3.3
extract
substance or resource obtained from a given element by a special method

3.4
thermal ageing factor
thermal stress that causes irreversible changes in the EIS

3.5
interfacial tension
adhesive forces between the liquid phase of one substance and either a solid, liquid or gas phase of another substance

3.6
autoclave
sealed tube
sealed container partially filled with the liquid EIM and which includes the solid EIM in relative component ratios which compare with the actual electrotechnical device

3.7
blister
small foam which is produced in the inner enamel layer of a winding wire

4 Electrical insulation material (EIM) evaluation

4.1 General description

This test procedure is useful for evaluating the chemical compatibility of insulation material (EIM) with the liquid (oil) and refrigerant at high temperature and high pressure.

The reference and candidate EIM shall be exposed to test periods at selected elevated temperatures and pressures. These test periods consist of a specific time exposure at the selected temperature and pressure followed by diagnostic tests.

A specific material is sealed in a stainless steel autoclave, subjected to a specified thermal ageing cycle and then subjected to each test. Candidate autoclave test results are then compared to the reference autoclave test results for qualification of the acceptability of the candidate EIM.

The test system consists of the following elements:

- autoclaves;
- ageing ovens;
- test objects.

4.2 Test equipment

4.2.1 Autoclave

Each autoclave is a container constructed of stainless steel. The size or the volume shall be determined by the size or the volume of the test objects, oil and refrigerant, excluding the electric resistance test and extract test. In general, 300 cm^3 to 500 cm^3 volume of autoclave is convenient and enough for each EIM test.

Either one or both ends of the cell shall be fitted with removable, sealable bolt-on covers.

The autoclave parts shall be provided for the pressure gage, pressure relief system, needle valve and gas sealing packing.

For specific details, see Figure 1.

Figure 1 – Autoclave example for ageing test of EIM

4.2.2 Ageing oven

An air circulating oven or oil bath can be used.

In case of an air circulating oven, the ovens used shall meet the requirements of IEC 60216-4-1:2006, 5.2 to 5.4 (temperature difference, fluctuation on variation).

In case of an oil bath, the oil level shall be maintained at a level high enough to provide appropriate heat transfer during the test. The oil shall have enough thermal endurance for the ageing test in this case.

4.3 Specimen

4.3.1 General

The following EIMs and components are applied as test subjects and evaluated by each diagnostic test as shown in Table 1.

Table 1 – Hermetic motor-compressor EIM and diagnostic test items

	Winding wire	Varnish	Film	Molding part	Tube	Tie cord	Oil	Refrigerant	Process oil[a]
Breakdown voltage	○	○	○		○				
Dielectric constant (ε)			○						
Electric resistivity							○	○	
Effect to electric resistivity of oil						○			
Effect to electric resistivity of refrigerant						○			
Tensile strength			○			○			
Flexual strength				○					
Elongation			○						
Blister	○								
Molecular weight change			○						
Extract	○	○	○	○	○	○			
Acidity							○		
Metal Surface contamination									○

Key:

○ = EIM that is applied to the qualification test.

[a] For example: winding wire winding lubricant, iron punching oil, die casting oil.

4.3.2 Determination of component shape, volume or weight of EIM

Excluding the resistance test and the extract test, the specimen shall be prepared as follows:

a) Winding wire:

- breakdown voltage: specimen shall be prepared in accordance with IEC 60851-5,
- relative permittivity (ε_r) and dielectric loss (tanδ): in accordance with IEC 60250,
- blister test: 100 mm in length,
- extract test: see 4.4.2.

b) Varnish:

- breakdown voltage: if included in the EIS, the impregnating varnish shall be applied to the winding wire samples as twisted pair and cured in accordance with the manufacturer's specifications,
- extract test: see 4.4.2.

c) Film:

- breakdown voltage: size 250 mm × 250 mm,
- relative permittivity (ε_r): size 100 mm × 100 mm,
- tensile strength and elongation: width = 10 mm to 25 mm, length = 100 mm,
- molecular weight; about 1,0 g,
- extract test: see Clause B.3

d) Molding part:

- bending strength: apply the practical part which is used in the compressor,
- extract test: see Clause B.3.

e) Tube:

- breakdown voltage: enough length that it does not cause flashover when the surface test pole length is 100 mm,
- extract test: see Article B.3.

f) Tie cord:

- tensile strength and elongation: enough length to chuck when the elongation measurement is 25 mm long,
- effect on the electric resistance of oil: the same ratio of the weight to the oil in the compressor is applied,
- effect on the electric resistance of refrigerant: the same ratio of the weight to the refrigerant in the compressor is applied,
- extract test: see Clause B.3.

g) Metallic part:

- surface contamination test: capillary tube longer than 100 mm ,
- see Clause B.4.

h) Oil:

- half the volume of the autoclave container shall be supplied for each ageing test,
- after the ageing, the test subject shall be removed from the autoclave and the oil shall be supplied to each diagnostic test.

i) Refrigerant:

- the refrigerant weight which is supplied to the autoclave shall be decided by the ageing pressure at the ageing temperature. The relation between the temperature and the pressure depends on the quality of each refrigerant.

NOTE The amount of the refrigerant ratio to the oil is different according to the ageing test temperatures for keeping the settled autoclave inner pressure.

4.3.3 Reference test subject

The reference test subject shall be composed of EIMs that have an established performance in combination with the same compressor component, oil and refrigerant.

4.4 Test procedures

4.4.1 General test procedure

The general test procedure shall be applied to the evaluation tests, excluding the electrical resistance of refrigerant test and extract test.

A three-temperature ageing test shall be completed to establish the thermal rating of the new EIM. A reference EIM shall be used to validate the testing of the candidate EIM.

A simplified single-point ageing can also be conducted for the purpose of quality control, minor product changes or for screening prior to a full three-point evaluation. The setup would be similar to that described for the three-point ageing.

While a complete thermal index may not be determined based on such a single-point test, this test could be used to understand the expected capability of a proposed candidate EIS without the time and effort of completing a full evaluation.

4.4.2 Preparation of the autoclave

The preparation of the autoclave assembly is as follows.

a) Cleaning of the autoclave: it shall be filled with an effective solvent, such as acetone, for 24 h or longer, scrubbed well with a detergent brush, rinsed thoroughly with tap water and then with distilled water, and finally dried.

b) Drying of the autoclave: the taps, nuts, and bolts shall be conditioned for at least 1 h in an oven maintained at 105 °C ± 2 K, and shall then be removed from the oven and the samples immediately inserted.

c) Setting of the specimen: the twisted pairs of wire shall be prepared in accordance with IEC 60851-5 before insertion in the autoclave. The other materials shall then be positioned inside the autoclave, avoiding contact with each other, if possible, so that there is no sticking during the ageing period.

d) The twisted pair shall be set up in the autoclave so that half of the twisted part is immersed into the oil. In case there are other EIMs, it is better to separate into two groups. One of the group (about half the amount of the specimen) shall be kept in oil, and the effect of oil checked.

e) Drying of the specimen: after the EIMs are set in the autoclave, the tube, gaskets, taps, nuts and bolts shall be dried for at least 1 h in an oven maintained at 105 °C ± 2 K. Certain materials may require additional conditioning to remove all moisture, if agreed upon by interested parties. Higher temperatures and times may be used to condition these materials prior to insertion in the autoclave.

f) Supplying of the oil: the oil is supplied into the autoclave. Oil volume is at about half the volume of the autoclave's inner volume. In this case, the water content of the oil shall be controlled.

g) Assembly of the autoclave: immediately after the supplying of the oil, the autoclave shall be closed, to prevent the oil from absorbing water.

h) Supplying of the refrigerant: in the autoclave a vacuum of 1 000 Pa to 2 000 Pa is generated and the pre-fixed amount of refrigerant is supplied.

i) Pressure control: the autoclave is inserted into the oven or the oil bath and the temperature is maintained at a settled temperature. After the autoclave temperature has settled, the autoclave pressure is set to the settled pressure by controlling the refrigerant

amount using the needle valve of the autoclave. Inspection of the autoclave sealing could be done by checking the pressure gauge.

4.4.3 Ageing

The autoclave shall be placed in the pre-heated thermal conditioning oven. The thermal conditioning oven shall not be opened during the conditioning cycle as this can affect the thermal ageing of the EIS under evaluation.

The ageing temperature and time shall be in accordance with IEC 60216-1.

The ageing temperature shall be selected at the temperature where the refrigerant oil or refrigerant is stable.

4.4.4 Opening procedure

After thermal conditioning of the autoclave, the oven shall be turned off and allowed to cool to room temperature before the autoclave is removed.

The autoclave shall be kept sealed, prior to evaluation, which is not to be delayed for more than three days. The autoclave shall then be opened and the EIMs components carefully removed and separated so as to reduce mechanical damage.

4.5 Diagnostic test

4.5.1 General

Samples of both the solid insulation and the liquid insulation shall be tested prior to start-up. After the ageing, each property of the solid insulation and the liquid shall be measured. Changes between the initial and final states shall be used to determine the amount of degradation occurring during the testing cycle. The results of the initial moisture content measurements shall be used to determine whether or not the materials are adequately dried prior to start-up.

4.5.2 Solid insulation materials

At start-up, the solid insulation samples shall be tested using one or more diagnostic tests to be chosen by the equipment technical committee to determine the end of life. Additional tests may be used for monitoring purposes. Evaluation tests and their method are shown in Table 2.

Table 2 – Diagnostic test and its method for solid insulation

	Evaluation test	Test EIM	Test method
Electric property	Breakdown voltage	Winding wire	IEC 60317-0-1
		Varnish	IEC 60317-0-1
		Film	IEC 60674-2
		Tube	IEC 60684-2
	Relative permittivity (ε_r)	Film	IEC 60250
	Effect on oil electric resistivity Effect on refrigerant electric resistivity	Tie cord	Clause B.1
Mechanical property	Tensile strength	Film	IEC 60674-2
		Tie cord	IEC 60684-2
	Elongation	Film	IEC 60674-2
	Flexural strength	Molding part	ISO 178[a]
	Blister	Winding wire	Clause B.2
Chemical property	Extract	Winding wire	Clause B.3
		Varnish	
		Film	
		Molding part	
		Tie cord	
	Molecular weight	Film	ASTM D4603
	Metal surface contamination	EIMs and process oil	Clause B.4

NOTE For solid insulation which includes enamel coated wires, most of the above test methods are not appropriate. In such cases, the key characteristic to monitor for the enamel coated wires is the dielectric strength retention. There has only been limited experience using such coated wires with this test method.

[a] The support span shall be decided by the examiner.

4.5.3 Liquid insulation material (refrigerant oil)

At start-up, the liquid insulation pre-conditioned according to 4.4.2 shall be tested using one or more diagnostic tests to be chosen by the equipment technical committee to determine the end of life. Additional tests may be used for monitoring purposes. Examples of typical diagnostic test for liquids are as follows (see Table 3):

Table 3 – Diagnostic test and its method for liquid insulation

Evaluation test	Test EIM	Test method
Electric resistivity	Oil	IEC 60247
	Refrigerant	IEC 60247
Acidity	Oil	IEC 62021 (all parts)

4.6 Analysis of data

4.6.1 End-point criteria

The criteria by which a test object is considered to have failed shall be fully defined prior to the start of the test. An adequate test shall be included in the test period to detect when a failure occurs, denoting the end of life for each test object. The use of more than one end-point criterion will tend to make interpretation of the test results more difficult. It is recommended that only one end-point criterion be used for each component in the test object (solid/liquid). The equipment technical committee for the EIS being modelled shall define the specific end-point criterion.

4.6.2 End-of-life of the oil and solid component

The preferred end-point criterion for the solid or oil insulation shall be the degradation of the original value of the selected mechanical, electrical and chemical properties.

Other choices for the end-point criterion are described in IEC 60216-2:2005, Table 1. The end of life value for the candidate EIS (such as 50 % tensile strength retention) shall be determined based on the test of the same component in the reference EIS.

The end point and criteria examples of thermal life are shown in Table A.1.

The total number of hours to end of life shall be recorded for the solid component in the test object at each ageing temperature. The life (in hours) at each ageing temperature shall be calculated according to IEC 60216-3.

4.6.3 Extrapolation of data

Linear regression analysis on the solid component data shall be carried out in accordance with IEC 60216-5.

5 Electrical insulation system (EIS) evaluation

5.1 General description

EIS evaluation uses the same method in accordance with IEC 61857-1 and IEC 61857-21 except the ageing environment which is applied to the refrigerant and refrigerant oil in the autoclave.

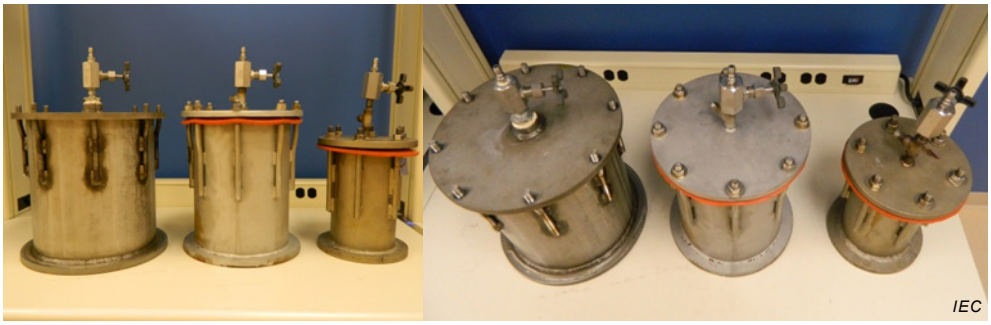
5.2 Test equipment

5.2.1 Autoclave

Each autoclave is a container constructed of stainless steel. The size or the volume shall be determined by the size or the volume of the test objects. Either one or both ends of the cell shall be fitted with removable, sealable bolt-on covers.

The autoclave parts shall be provided for pressure gauge, pressure relief system, needle valve and gas sealing packing.

Two examples of the autoclave for EIS ageing are shown in Figure 2.



Source: ELTEK International Laboratories

Figure 2 – Examples of the autoclave for EIS ageing

5.2.2 Ageing oven

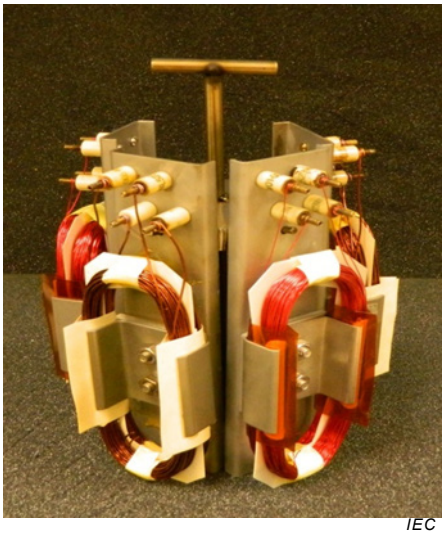
The air circulating oven shall be used and meet the requirements of IEC 60216-4-1:2006, 5.2 through 5.4 (temperature difference, fluctuation on variation).

5.2.3 Specimen mounting tool

The GPM (general purpose model) specimen is mounted in the autoclave by using an adequate tool for keeping the oil immersion length and avoiding contact with each other. Examples of mounting tool for EIS and of GPM mounting are shown in Figure 3, and Figure 4

Source: ELTEK International Laboratories.

Figure 3 – Mounting tool



Source: ELTEK International Laboratories.

Figure 4 – Example of GPM mounting

5.3 Specimen

For the evaluation of EIS, the GPM shall be applied in accordance with IEC 61857-21.

The minimum number of test objects in a group for each ageing temperature shall be 5.

5.4 Test procedure

5.4.1 Initial screening test

Prior to the ageing test, all test objects shall be subjected to the initial screening test in accordance with IEC 61857-21:2009, 6.2.2.

5.4.2 Preparation of the autoclave

The preparation of the autoclave shall be done in accordance with 4.4.2.

In this case, the volume of the oil is controlled to about half of the autoclave volume so that the GPM shall be capable of being immersed to half of its length.

5.4.3 Thermal endurance test

5.4.3.1 General

Following the mounting of the GPM in the autoclave, the autoclave shall be placed in the pre-heated thermal conditioning oven. All test objects shall be subjected to repeated thermal endurance test cycles consisting of sub-cycle in the following order:

a) thermal ageing by exposure to refrigerant and refrigerant oil;

b) mechanical stress;

c) thermal shock;

d) dielectric diagnostic test.

5.4.3.2 Thermal ageing by exposure to refrigerant and refrigerant oil (5.4.3.1 a))

The thermal conditioning oven shall not be opened during the conditioning cycle as this can affect the thermal ageing of the EIS under evaluation. The ageing temperature and time shall be in accordance with IEC 61857-1:2008, 6.3.

At the ageing temperature the refrigerant oil or refrigerant need to be stable.

5.4.3.3 Mechanical stress (5.4.3.1 b))

The mechanical stress shall be applied in accordance with IEC 61857-21:2009, 6.3.3.

5.4.3.4 Thermal shock (5.4.3.1 c))

The thermal shock shall be applied in accordance with IEC 61857-21:2009, 6.3.4.

5.4.3.5 Dielectric diagnostic test (5.4.3.1 d))

Following each ageing cycle, the dielectric diagnostic test shall be applied in accordance with IEC 61857-21:2009, 6.3.6 (in this case, moisture exposure cycle shall not be applied).

5.5 End of life criterion

The end of life criterion shall be defined in accordance with IEC 61857-21:2009, Clause 7.

5.6 Analysis of data

Analysing of average life, extrapolation of regression line and relative thermal index shall be calculated in accordance with IEC 61857-1:2008, 7.2 and 7.3.

6 Report

The report shall include all records, relevant details of the test, and analysis, including

– reference to this document,

– description of the EIS tested (reference and candidate EIS),

– ageing temperatures and ageing periods of each EIS,

– sealing method used for evaluation,
– diagnostic tests and end-point criterion used for each EIS,
– detailed description of the test objects (including volumetric ratios),
– number of test objects at each temperature for each EIS,
– individual times to end-of-life for each component,
– mean log times to end-of-life for each ageing temperature, for each EIS.

Multiple-point ageing tests shall also include

- regression line with log mean points, for the solid component,
- regression equation and coefficient of correlation for the solid component,
- EIS ATI and/or thermal class of the reference EIS solid component,
- EIS RTI and assigned thermal class of the candidate EIS solid component.

Annex A
(informative)

End-point and criteria examples of thermal life

Table A.1 – End-point and criteria example of thermal life

EIM&EIS	Diagnostic test	End-point
Winding wire	Breakdown voltage	50 % of initial value
	Blister	Equal or more than the reference
	Dielectric loss	Equal or higher than the reference value
	Extract	More than 0,2 % at 500 h or Equal or more than the reference value
Varnish	Extract	More than 1,0 % at 500 h or More than 80 % of the reference value
Film	Breakdown voltage	50 % of initial value
	Tensile strength	50 % of initial value
	Elongation	10 % of initial value
	Molecular weight change	Equal or more than the reference
	Extract	More than 1,0 % at 500 h or Equal or more than 80 % of the reference
Molding part	Bending strength	50 % of initial value
	Extract	Equal or more than the reference value
Tube	Breakdown voltage	50 % of initial value
	Extract	Equal or more than the reference value
Tie cord	Tensile strength	50 % of initial value
	Extract	Equal or more than 80 % of the reference value
	Effect to electric resistance of oil	To keep the original value
	Effect to electric resistance of refrigerant	To keep the original value
Oil	Electric resistance	Equal or less than the reference value
	Acidity	10 times increase of original value
Refrigerant	Electric resistance	Equal or less than the reference value

Annex B
(informative)

Suggested test procedures

B.1 Test procedures for effect to the electric resistance of oil and refrigerant

B.1.1 General

These procedures shall be applied to the electric resistance test of the oil and the refrigerant separately. They shall be applied to check the effect of each cord and sleeves that contain the surface activator on its surfaces.

B.1.2 Autoclave

The autoclave's inner volume of 300 cm^3 to 500 cm^3 is convenient for the test treatment and about 100 g oil or refrigerant for each test shall be applied with the test subject.

B.1.3 Test subject

Textile material such as tie cord or sleeves shall be applied. More than twice the weight ratio to the oil or refrigerant in the practical motor shall be applied to the test.

B.1.4 Test process

The test process is as follows:

a) In case of the oil electric resistance

   The tie cord or sleeves are supplied to the autoclave with the oil. After sealing the autoclave, it is kept 24 h at the settled temperature. The oil electric resistivity is measured at room temperature in accordance with IEC 60247.

b) In case of the refrigerant electric resistance

   The tie cord or sleeves are supplied to the autoclave with the refrigerant. After sealing the autoclave, it is kept 24 h at the settled temperature and pressure. The refrigerant electric resistivity is measured at the temperature lower than its boiling temperature of 1 MPa in accordance with IEC 60247.

B.2 Blister test of winding wire

B.2.1 Overview

After the ageing test, the autoclave is opened and the winding wire is removed. Immediately (within a few minutes) after removal from the autoclave, it shall be inserted and kept 5 min in the oven of which temperature is settled at 200 °C. After removal from the oven, the surface of the magnet wire is observed by using about a 2x magnifier. Any small foam or surface change shall be considered as a blister.

B.2.2 General

This procedure shall be applied to the extract test of EIMs for refrigerant.

B.2.3 Autoclave

The autoclave inner volume of 300 cm^3 to 500 cm^3 is convenient for the test treatment and about 100 g refrigerant for each test shall be applied with the test subject.

B.2.4 Test subject

Winding wire: About 1,0 g enamel layer shall be applied to the winding wire which shall be shaped to the helical of the diameter which is smaller than the inner size of the autoclave.

Varnish: About 1,0 g to 2,0 g of varnish is applied as metal plate coating which is cured to the plate in accordance with the specification of the manufacturer.

Film: About 1,0 g to 2,0 g of film is applied by cutting it to the suitable size.

Molding part: The original molding part shall be supplied.

Tube: About 1,0 g to 2,0 g of tube is supplied by cutting it to the suitable size.

Tie cord: About 1,0 g to 2,0 g of tie cord is supplied by cutting it to a suitable length.

B.2.5 Test process

The test EIM weight is measured precisely. Each test subject is separately inserted with the refrigerant (about 100 g) in the autoclave. The autoclave is kept for the testing time at the settled temperature and settled pressure. After keeping the testing time, the autoclave is cooled to room temperature. Then, the refrigerant is slowly evaporated from the autoclave and the test EIM is removed from the autoclave. The test EIM is rinsed with methyl alcohol and dried about 1 h at 100 °C. The test EIM is weighted at room temperature and the weight difference before and after the test is calculated.

B.2.6 Test result

The extract of the EIM is calculated as follows:

Extract (%) =
[(EIM weight before test) – (EIM weight after test)]/(EIM weight before test)

B.3 Refrigerant extract test for solid insulating materials

B.3.1 General

This procedure should be applied to the extract test of EIMs for the refrigerant.

B.3.2 Autoclave

The autoclave inner volume of 300 cm^3 to 500 cm^3 is convenient for the test treatment and about 100 g of refrigerant for each test should be applied with the test subject.

B.3.3 Test subject

Winding wire: About 1,0 g enamel layer should be applied to the winding wire which should be shaped to the helical of the diameter that is smaller than the inner size of the autoclave.

Varnish: About 1,0 g to 2,0 g of varnish is applied as metal plate coating which is cured to the plate in accordance with the specification of the manufacturer.

Film: About 1,0 g to 2,0 g of film is applied by cutting it to the suitable size.

Molding part: The original molding part should be supplied.

Tube: About 1,0 g to 2,0 g of tube is supplied by cutting it to the suitable size.

Tie cord: About 1,0 g to 2,0 g of tie cord is supplied by cutting it to the suitable length.

B.3.4 Test process

The test EIM weight is measured precisely. Each test subject is separately inserted with the refrigerant (about 100 g) in the autoclave. The autoclave is kept for testing time at settled temperature and settled pressure. After keeping the testing time, the autoclave is cooled to room temperature. Then, the refrigerant is slowly evaporated from the autoclave and the test EIM is removed from the autoclave. The test EIM is rinsed with methyl alcohol and dried about 1 h at 100 °C. The test EIM is weighted at room temperature and the weight difference before and after the test is calculated.

B.3.5 Test result

The extract of the EIM is calculated as follows:

Extract (%) =
[(EIM weight before test) – (EIM weight after test)]/(EIM weight before test)

B.4 Metal surface contamination test

B.4.1 General

This test is applied to check the capillary tube contamination or deposition of the EIM extract or the contents of the process oil.

B.4.2 Test procedure

The procedure is as follows:

a) Insertion of the test part into the 300 cm^3 stainless steel autoclave: refrigerant 50 g, refrigerant oil 100 g and capillary tube of 100 mm with the following EIMs or process oils:
   – winding wire: φ 1,0, 100 mm, 5 pieces;
   – varnish (cured to iron plate); about 1,0 g;
   – film, tube, tie cord; about 1,0 g;
   – process oil of die casting, winding process and iron punching, if necessary.
b) Ageing 72 h at the temperature of the compressor thermal class.
c) After ageing, the capillary tube is removed from the autoclave at room temperature and its surface colour shall be checked by comparing it to the original one.
d) The surface colour change and deposit of the extract criteria shall be defined by the experimental data.

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