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Insulation specification for frequency conversion machine

变频调速电机绝缘规范

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Insulation specification for frequency conversion machine

1 Scope

This document specifies the technical requirements, test methods, test equipment and inspection rules for insulation of frequency conversion machine.

This document is applicable to frequency conversion machine with rated voltage of 1 140 V and below. It serves as a reference for the implementation of high-voltage variable-frequency motors with a rated voltage higher than 1 140 V.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 4074.7-2024, Test methods of winding wires - Part 7: Test procedure for the determination of the temperature index of enamelled winding wires

GB/T 5591.3-2018 Combined flexible materials for electrical insulation - Part 3: Specifications for individual materials

GB/T 6109.1, Enamelled round winding wire - Part 1: General requirements

GB/T 7095.1, Enamelled rectangular copper winding wires - Part 1: General requirements

GB/T 11026.4-2012, Electrical insulating materials - Thermal endurance properties - Part 4: Ageing ovens - Single-chamber ovens

GB/T 17948.1-2018, Rotating electrical machines - Functional evaluation of insulation systems - Test procedures for wire-wound windings - Thermal evaluation and classification

GB/T 17948.3-2017, Rotating electrical machines - Functional evaluation of insulation systems - Test procedures for form-wound windings - Thermal evaluation and classification of insulation systems used in rotating machines

GB/T 20629.3-2019, Non-cellulosic papers for electrical purposes - Part 3: Unfilled aramid (aromatic polyamide) papers

GB/T 22720.1-2017, Rotating electrical machines - Qualification and quality control tests of partial discharge free electrical insulation systems (Type j) used in rotating electrical machines fed from voltage converters

GB/T 22720.2-2019, Rotating electrical machines - Qualification tests for the partial discharge resistant electrical insulation systems (Type II) used in rotating electrical machines fed from voltage converters

JB/T 10508-2020, Specifications for slot wedges used in small and middle size electric machines

3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those given in GB/T 22720.1-2017, apply.

3.1

type I insulation systems

The insulation structure, for converter-powered motors, which is not subject to partial discharge during its service life.

3.2

type II insulation systems

The insulation structure, for converter-powered motors, which is subject to partial discharge in any part during its service life.

Note: Generally, motors with a rated voltage greater than or equal to 700 V are of type II insulation systems.

3.3

impulse voltage insulation class; IVIC

The safe peak-to-peak voltage, for inverter-powered motors, specified by the manufacturer and related to the rated voltage, which shall be indicated in the instructions and on the nameplate.

[Source: GB/T 22720.1-2017, 3.19, modified]

3.4

partial discharge; PD

3.12

rated voltage

U_N

The voltage value of the motor under power frequency operating conditions, which is specified by the manufacturer and marked on the nameplate.

Note 1: The rated voltage is the line end rated voltage and is the effective value.

Note 2: For electric vehicle drive motors, the rated voltage is the nominal voltage of the DC bus declared by the manufacturer, in which case $U_N = U_{dc}$.

[Source: GB/T 22720.1-2017, 3.18]

3.13

overshoot factor; OF

The ratio of the motor terminal display voltage to the converter voltage.

[Source: GB/T 22720.1-2017, 3.24]

4 Technical requirements

4.1 Requirements for single materials

4.1.1 Electromagnetic wire

4.1.1.1 General requirements

In addition to meeting the requirements of Table 1, the electromagnetic wire shall also withstand the tension during the winding process, and the paint film/insulation layer shall have a certain degree of flexibility during the winding process, without cracking or losing adhesion.

4.1.1.2 High-frequency impact resistance

The chemical structure and coating process of the electromagnetic wire paint film shall enable the electromagnetic wire to effectively withstand the long-term impact of high-frequency impulse voltage. Under the conditions described in 4.3.1.2, the high-

When using mica tape for insulation, its general performance shall meet the technical requirements of the relevant mica tape product standards.

4.1.4 Slot wedge

The heat resistance grade of the slot wedge shall not be lower than 155(F), and its conventional performance shall meet the technical requirements of JB/T 10508-2020.

4.1.5 Lead wire

The conductor inside the lead wire shall be guaranteed to operate continuously at a temperature not lower than 125 °C. The connection between the lead wire and the winding wire can be protected by corresponding thermal-setting adhesive tape, and its general performance shall meet the relevant product technical requirements.

4.1.6 Casing

The heat resistance grade of the casing shall not be lower than 155(F), and its conventional performance shall meet the relevant product technical requirements.

4.2 Technical requirements for insulation structure

4.2.1 Heat resistance grade

The heat resistance grade corresponding to the continuous use design life of the insulation structure shall not be lower than 155(F).

4.2.2 Technical requirements for type I insulation systems

Type I insulation systems shall meet the technical requirements of GB/T 22720.1-2017.

4.2.3 Technical requirements for type II insulation systems

Type II insulation systems shall meet the technical requirements of GB/T 22720.2-2019.

4.2.4 High-frequency impact resistance requirements

The design and manufacturing process of type II insulation systems shall enable the insulation structure to effectively withstand long-term impact of high-frequency impulse voltage. For the high-frequency impact resistance of the insulation structure evaluated under the conditions described in 4.3.6.2, the insulation structure shall meet the requirements of Table 4.

Bipolar high-frequency impulse voltage is preferred for testing. If the test voltage is too high to meet the requirements, such as exceeding 20 kV, the test method in Appendix C of GB/T 22720.2-2019 may be used after consultation between the supply and demand parties, and its requirements shall be met.

5 Test methods and test equipment

5.1 Evaluation of high-frequency impact resistance of electromagnetic wire

5.1.1 Test sample

For the evaluation of the high frequency impact resistance of electromagnetic wire, prepare the test samples as follows.

- a) Enameled round copper wire: Prepare into "twisted pair" form according to the provisions of 5.1.1 of GB/T 4074.7-2024.
- b) Enameled rectangular copper wire: Prepare into "back-to-back" form according to the provisions of 5.1.2 of GB/T 4074.7-2024. Straightening can be done by stretching the sample by no more than 1% of its total length, and tying the two lines tightly together with a high-temperature binding wire that can withstand long-term use of 155°C and above. The length of the "back-to-back" straight part is 150 mm.

5.1.2 Test conditions

In an aging oven at a temperature of 155 °C (the aging oven shall meet the relevant provisions of GB/T 11026.4-2012), the electromagnetic wire samples are continuously tested using a high-frequency impact tester with the parameters shown in Table 5. The measurement guidelines for waveform parameters of high-frequency impact testers are given in Appendix A.

5.1.3 Test results

When evaluating the high-frequency impact resistance of 5 samples, take the median and minimum values as the sample results.

5.2 Determination of volatile matter of impregnating resin

The method for determining the volatile matter of the impregnating resin is shown in Appendix C.

5.3 Heat resistance assessment of insulation structures

The heat resistance assessment of insulation structures shall be carried out in accordance with the provisions of GB/T 17948.1-2018 or GB/T 17948.3-2017.

For the heat resistance assessment of insulation structures under special working conditions, Appendix D provides an example of the heat resistance assessment of the insulation structure of the drive motor of a new energy vehicle.

5.4 Evaluation of type I insulation systems

Appendix E briefly describes the evaluation procedures for type I insulation systems and type II insulation systems of variable frequency motors.

Evaluate the type I insulation systems according to the procedures of GB/T 22720.1-2017, as described in E.2. Based on the identification test results, obtain the impulse voltage insulation class of the insulation system according to the method described in E.2.3.

5.5 Evaluation of type II insulation systems

Evaluate the type II insulation systems according to the procedures of GB/T 22720.2-2019, as described in E.3.

5.6 Evaluation of high-frequency impact resistance of insulation structures

5.6.1 Test products and test samples

The test may be carried out using a randomly wound dummy coil (motorette), a formed wound dummy coil (formette), an actual motor stator winding or a portion of an actual winding. The test product is a complete fixture containing a test sample, and the test sample is the coil in the test product. Each test product may contain several individual test samples.

5.6.3 Test results

For the model coil, 5 test samples shall be used to evaluate the high-frequency impact resistance performance. For the actual winding, 3 test samples shall be used to evaluate the high-frequency impact resistance performance. The median and minimum values shall be taken as the test results.

6 Inspection rules

6.1 Inspection of single insulating materials and electromagnetic wires

The high-frequency impact resistance of electromagnetic wires shall be tested during the first batch of purchase confirmation and annual random inspection.

For other insulating materials, follow the normal incoming inspection method.

6.2 Inspection of the overall insulation structure

Inspection of the overall insulation structure of the motor shall be carried out during motor product identification and when the insulation structure is changed.

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Contact: Wayne Zheng, Sales@ChineseStandard.net

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