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**INDUSTRY STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

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**Test method of average moisture content in transformer
insulation paper and paperboard Frequency domain dielectric
spectroscopy method**

变压器绝缘纸（板）平均含水量测定法频域介电谱法
(English Translation)

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Foreword

This standard is formulated in accordance with the rules of GB/T 1.1-2009 "Standardization Guidelines Part 1: Standard Structure and Compilation".

Please note that certain contents of this document may involve patents. The issuing agency of this document is not responsible for identifying these patents.

This standard was proposed by the China Electricity Council.

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1 Scope

This standard specifies the method for measuring the average moisture content of insulating paper (board) of equipment such as oil-immersed transformers, reactors and bushings by frequency domain dielectric spectroscopy.

Method summary, instruments and materials used, measurement methods, etc.

This standard applies to the determination of the average moisture content of the insulating paper (board) of equipment such as oil-immersed transformers, reactors and bushings, including the Insulating paper (board), new paper (board) sample testing and overall testing of non-sampling field equipment.

2 Normative references

The following documents are indispensable for the application of this document. For dated reference documents, only the dated version applies to this document.

For undated references, the latest version (including all amendments) applies to this document.

GB/T 1410 Test method for volume resistivity and surface resistivity of solid insulating materials
DL/T 449 Determination of water content of oil-impregnated fibrous insulating materials
DL/T 474.3 Implementation guidelines for on-site insulation test Dielectric loss factor $\tan\delta$ test
DL/T 596 Preventive test procedures for electrical equipment

3 Method overview

Conduct frequency domain dielectric spectroscopy on insulating paper (board) and new paper (board) samples of oil-immersed transformers, reactors and bushings, and field equipment for measurement, compare the measurement curve with the standard curve database to obtain the average moisture content of the insulation paper (board) in the sample or device under test.

4 Terms and definitions

The following terms and definitions apply to this standard.

4.1 Dielectric response

The response characteristics of the electrical performance parameters of the dielectric with time and frequency under the applied voltage are called time domain dielectric response and frequency domain dielectric response, respectively.

Electric response.

4.2 Frequency domain dielectric spectrum

The response curve of dielectric parameters such as dielectric coefficient and dielectric loss factor changing with frequency.

4.3 XY model

Simplify the model according to the proportions of the dimensional relationship between the oil gap, stays and cardboard in the oil-immersed transformer and reactor, X represents the insulation system There is the ratio of the sum of the thickness of the cardboard to the sum of the thickness of all the stays, Y represents the sum of the width of all the stays and the sum of all the widths of the cardboard in the insulation system Ratio.

5.1 Frequency domain dielectric spectrum tester

Including low-voltage broadband signal source, high-voltage broadband amplifier and micro-current detection module. After the instrument runs stably, the following indicators should be reached.

- a) The frequency measurement range is 0.1mHz~5kHz;
- b) Dielectric loss measurement range 0~10;
- c) The capacitance measurement range is 10pF~100μF;
- d) The maximum value and resolution of current measurement is 20mA/10pA;
- e) Support the water content evaluation function of transformer insulation paper (board).

5.2 Measuring electrode

The measuring electrode (used for measurement in the laboratory) is a three-electrode structure, including a high-voltage electrode, a protected electrode and a protective electrode, as shown in the figure

Table 1 shows the typical dimensions. The measuring electrode should be kept clean, dry and stored in a desiccator.

5.3 Reagents

Petroleum ether. analytically pure, boiling range 60°C~90°C.

Anhydrous ethanol. analytically pure.

6.1.1 Sample preparation

For paper (board) samples (oil-containing) and new paper (board) samples taken from oil immersion equipment, pre-dried sharp metal work can be used Use a razor blade or

scissors to cut the sample. The sample size should be larger than the outer diameter of the high-voltage electrode. Then put the sample into a clean plastic with self-sealing function.

The material is sealed in a sealed bag, after air is discharged, sealed, and stored in a sealed bottle. The samples should be tested as soon as possible after collection, and the recommended storage time should not exceed 7 days.

6.1.2 Measurement procedure

6.1.2.1

Take out the measuring electrode from the desiccator, use tweezers to put the sample under test into the measuring electrode, make the sample and the high-voltage electrode, the protected electric the electrode and the protective electrode are in full contact to ensure that there is no air gap, and then the measuring electrode is placed in a metal shielding box. The sample should completely cover the protective electrode, and it does not touch the inner wall of the shielding box.

6.1.2.2

Connect the protected electrode of the three electrodes to the measuring terminal of the tester, the high-voltage electrode to the high-voltage terminal of the tester, and the protective electrode to the screen the shielding box and the shielding end of the tester are connected, and the test connecting wires are all coaxial shielded wires.

6.1.2.3

Record the ambient temperature, turn on the tester, and start measurement after 5 minutes of stable operation to obtain the frequency domain dielectric spectrum curve of the tested sample.

The water content of the tested sample is calculated according to the standard curve database equipped with the instrument.

6.1.2.4

After the test is completed, turn off the power of the test instrument, clean the measuring electrode with petroleum ether, dry it and store it in a desiccator.

6.2.1 Test preparation

Before the test, remove all the leads connected to the end of the casing of the device under test, remove the debris around the device, and fully discharge the device.

If necessary, clean or dry the outer insulating surface of the equipment.