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Method of Humidity Measurement of Sulfur Hexafluoride Insulated Gas in Electrical Equipment

六氟化硫电气设备中绝缘气体湿度测量方法

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Table of Contents

Method of Humidity Measurement of Sulfur Hexafluoride Insulated Gas in Electrical Equipment

1 Scope

This Standard specifies the method for measuring the humidity of insulated gas in sulfur hexafluoride electrical equipment.

This Standard is applicable to the measurement of the humidity of the insulated gas in sulfur hexafluoride electrical equipment in the type test, exit-factory test, handover test and preventive test. The mixed gas insulated electrical equipment can be implemented as a reference.

2 Normative References

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this document.

DL/T 639 Safety and Protection Rules for Operation, Test and Maintenance Personnel of SF6 in Electrical Apparatus

3 Terms and Definitions

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

3.1 Water vapour

It is also called water vapor. The gaseous state of water, which is formed by the vaporization of water or the sublimation of ice.

3.2 Humidity

The content of water vapor in the gas.

3.3 Dry gas

Gas that contains no water vapor.

The percentage of the molar fraction of water vapor in wet gas to the molar fraction of saturated water vapor at the same temperature and pressure; or the ratio of the partial pressure of water vapor in wet gas to the saturated water vapor pressure at the same temperature.

3.14 Uncertainty of measurement

It characterizes the evaluation of the range of the measured true value.

3.15 Humidity meter

The general term for instruments that measure the humidity of a gas.

3.16 Error of indication of a measuring instrument

The indication value of the measuring instrument minus the true value of the corresponding input quantity.

3.17 Fiducial error of a measuring instrument

The percentage of indication error of the measuring instrument and the instrument range.

4 Requirements for Humidity Meter

4.1 The used humidity meter shall meet the following requirements when the ambient humidity is 10°C~40°C:

--- The measuring range of the electrolytic humidity meter shall satisfy 1μL/L~1000μL/L.

--- Fiducial error: within the range of 1μL/L~30μL/L, it shall not exceed ±10%;

within the range of 30μL/L~1000μL/L, it shall not exceed ±5%.

4.2 The measuring dew-point range of the chilled dew-point meter shall satisfy 0°C~ -70°C when the ambient temperature is 20°C; and the measurement error shall not exceed ±0.6°C.

4.3 The dew-point range of resistance capacitive humidity measurement shall satisfy 0°C~-60°C; and the measurement error shall not exceed ±2.0°C.

4.4 The humidity meter shall be checked and calibrated regularly; and the validity period of the calibration result certificate is one year.

5 Requirements for the Measurement Gas Circuit System

5.1 The measuring pipeline must be made of stainless steel, copper or polytetrafluoroethylene, with a wall thickness of no less than 1mm and an inner diameter of 2mm~4mm. The inner wall of the pipeline shall be smooth and clean; and it is not allowed to use pipelines with strong water absorption capacity, such as rubber pipes and polyvinyl chloride pipes, etc.

5.2 The joints are required to be well sealed, clean, and free from damage and burrs. It is made of stainless steel or brass, and it is forbidden to use iron joints.

5.3 Use red copper gaskets or polytetrafluoroethylene gaskets for the inner pads. The joints shall be clean; and contaminants such as flux and grease shall be removed.

5.4 The cleaning method of the pipeline shall meet the following requirements:

a) Cleaning of stainless-steel pipes. Unused or heavily contaminated stainless-steel pipes must be cleaned before use. When cleaning, rinse by 5% hot trisodium phosphate, then rinse by distilled water to neutral; finally, rinse with absolute ethanol; and then dry by high-purity nitrogen and seal both ends of the pipe for later-use.

b) Cleaning of polytetrafluoroethylene pipe. The unused polytetrafluoroethylene pipe is generally rinsed by distilled water first; then rinsed by absolute ethanol once; finally, dried by high-purity nitrogen; and sealed at both ends for later-use.

5.5 Before connecting the measuring pipeline and joints to the equipment, make sure that the equipment joints are clean and dry, and then connect to the instrument.

5.6 The gas outlet of the measuring instrument shall be equipped with an exhaust pipe of more than 5m to prevent moisture in the atmosphere from affecting the measurement results.

6 Requirements for Measuring Ambient Temperature and Humidity

6.1 The ambient temperature shall be between 10°C ~ 40°C (measure between 10°C and 30°C as much as possible).

6.2 The relative humidity shall be no greater than 85%.

9.2.5 Disassemble the connection between the measuring gas circuit and the sampling joint of the equipment. Close the sampling valve on the equipment; disassemble the sampling joint on the connected equipment; cover (connect) the sealing cover (plate) of the equipment sampling joint; and restore the sealing of the equipment sampling joint.

9.2.6 Leak detection at the sampling port of the equipment. After restoring the sealing of the sampling port of the equipment, check by a sulfur hexafluoride leak detector to ensure that the sealing of the sampling port of the equipment does not leak.

9.2.7 After using the instrument, dry and blow by nitrogen for 15min ~ 20min, then turn off the instrument; and seal the inlet and outlet of the instrument for later-use.

9.2.8 The method of using the instrument refers to the instruction manual of the instrument.

10 Temperature Conversion of Measurement Results

10.1 Since the ambient temperature has a significant effect on the gas humidity in the equipment, the measurement results shall be converted to the value at 20°C in accordance with Appendix C.

10.2 If the equipment manufacturer provides conversion curves and charts, the curves and charts provided by the manufacturer can be used for temperature conversion.

11 Safety Precautions

11.1 Safety precautions shall be taken when testing the equipment while it is live.

11.2 During the test, the test site shall be ventilated.

11.3 The safety protection of test personnel shall be implemented in accordance with the relevant provisions of DL/T 639.

12 Report on Measurement Results

The report on measurement results shall include the following:

a) The name, model, exit-factory number, and exit-factory date of the tested equipment;

b) The name, model, exit-factory number, calibration date of humidity meter;

Appendix A

(Informative)

Conversion Formula of Humidity Measurement

A.1 When measuring the humidity in the gas, it can be expressed in various measurement units. Such as dew point, saturated water vapor pressure, volume ratio, weight ratio, absolute humidity, relative humidity. The measured dew point can be used to convert between measurement units.

The symbols and meanings are as follows:

e_d – saturated water vapor pressure under measuring dew point, in Pa;

NOTE: When the dew-point is lower than 0°C, if the condensate on the surface of the dew sensor is supercooled water, take the saturated water vapor pressure on the surface of the supercooled water; if the condensate on the surface of the dew sensor is ice crystals, take the saturated water vapor pressure on the ice surface.

P_t – total pressure of the measurement system, in Pa;

V_r – volume ratio, in μL/L;

W_r – weight ratio, in μg/g;

M_w – relative molecular mass of the water vapour;

M_t – relative molecular mass of the test gas;

e_s – saturated water vapor pressure of the water under the measuring temperature, in Pa;

U – relative humidity, in %;

T_a – temperature of gas sample, in K;

d_v – absolute humidity, in g/L;

SVP_0 – saturated water vapor pressure under the measuring pressure, in Pa;

SVP_a – saturated water vapor pressure under the atmospheric pressure, in Pa;

P_0 – absolute working pressure in the equipment, in Pa;

P_a – atmospheric pressure, in Pa.

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