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Power transformers - Additional European requirements - Part 2-4: Medium power transformer - Special tests

Transformateurs de puissance - Exigences européennes supplémentaires - Partie 2-4 : Transformateurs de moyenne puissance - Essais spéciaux

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European foreword

This document (EN 50708-2-4:2022) has been prepared by CLC/TC 14 “Power transformers”.

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2023-07-25
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Introduction

This document defines the rules for the assessment of energy performance to ensure the product conformity to the EU Regulation 548/2014 and amendment of 2019.

Regulation leads to have a minimum level of energy performances of power transformers.

NOTE In the document the term Regulation refers to the EU Regulation 548/2014 and amendment of 2019.

For the purpose of this document, the requirements of EN 50708-1-1 apply.

This document contains particular requirements for specific transformers or transformer applications, which are based on the requirements of EN 50708-1-1.

This document should be considered in conjunction with the requirements of the general parts.

The particular requirements of the different sub parts of EN 50708 supplement, modify or replace certain requirements of the general parts of EN 50708-1 and/or EN 50708-1-X being valid at the time of publication of this document. The absence of references to the exclusion of a part or a clause of a general part means that the corresponding clauses of the general part are applicable (undated reference).

Requirements of other -X parts with X greater than 1 being eventually relevant for cases covered by this document also apply. This document could therefore also supplement, modify or replace certain of these requirements valid at the time of publication of this document.

The main clause numbering of each part follows the pattern and corresponding references of EN 50708-1-1. The numbers following the particular number of this document are those of the corresponding parts, or clauses of the other parts of the EN 50708 series, valid at the time of publication of this document, as indicated in the normative references of this document (dated reference).In the case where new or amended general parts with modified numbering were published after the sub part was issued, the clause numbers referring to a general part in sub parts might no longer align with the latest edition of the general part. Dated references should be observed.

1 Scope

This document describes the special tests for Medium Power Transformers ≤ 3150 kVA compliant with the EN 50708-2 series:

— for corrugated tank for liquid immersed transformers,

— for the method of measurement of losses for one winding in Highest Voltage (HV) and windings in Lowest Voltage (LV) for liquid immersed and dry type transformers.

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.

EN 50708 (series), *Power transformers — Additional European requirements*

EN 60076-1:2011, *Power transformers — Part 1: General*

IEC 60076-8, *Power transformers — Part 8: Application guide*

EN IEC 60076-11:2018,[1] *Power transformers — Part 11: Dry-type transformers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the EN 50708 series apply.

4 Service conditions

Refer to EN 60076-1.

5 Special test for corrugated tank

5.1 General information

For liquid immersed transformers with a corrugated tank a special test to check the reliability of the tank along the life is described here after.

This test is representative of the life cycle of the tank of the transformers under operation and ensures a relevant level of quality. Other kinds of tests can be carried out by agreement between the manufacturer and the customer at the time of the offer.

To avoid accident by overpressure in the tank, the manufacturer should indicate maximum value that has not been exceeded. If these pressures are reached, then the tests are not to be carried out.

5.2 Temperature variation

For the simulation of the seasonal and daily temperature variations, the average liquid temperature is assumed to vary between −25 °C and +88 °C.

By agreement between manufacturer and purchaser the maximum temperature used for the endurance test shall be 40°C plus 0,8 times the liquid temperature rise determined by the temperature rise test.

NOTE 1 −25 °C Is the minimum ambient temperature with de-energised transformer.

[1] As impacted by EN IEC 60076-11:2018/AC:2019-06.

NOTE 2 88 °C is the sum of maximum ambient temperature +40 °C and maximum allowed average oil temperature rise: 0,8 × 60 K = 48 K. The factor 0,8 is the standardized value to get the average oil temperature.

NOTE 3 The coefficient 0,8 is the usual coefficient to determine the average liquid temperature for ONAN. The average liquid temperature can be also determined by EN 60076-2 method.

5.3 Sealing temperature

When sealing the tank, the average liquid temperature shall be chosen between 15 °C and 35 °C and recorded. A pressure device (Manometer or digital pressure sensor) connected to the tank cover shall register the value zero.

5.4 Calculation of the liquid volume variation

From the temperature variations above, the liquid volume variation from the relaxed stage at the sealing temperature shall be calculated using a volume expansion coefficient given by suppliers and generally equal to $7,5 \times 10^{-4}$ (±10 %) K^{-1} for mineral oil.

The following value may be taken for other liquids if no information is given by suppliers:

— Silicone 10×10^{-4} K^{-1}

— Natural ester $7,4 \times 10^{-4}$ K^{-1}

— Synthetic ester $7,5 \times 10^{-4}$ K^{-1}

NOTE Relaxed tank is the stage at sealing temperature means tank filled of oil, temperature of oil stabilized and the overpressure at 0.

The volume of liquid to be considered for thermal expansion is the actual volume of liquid and not the total tank volume.

The volume of the active part should be deducted from the tank volume.

5.5 Test procedure

5.5.1 General

These tests are considered as special tests.

The tests can be done either with or without active parts. The volume to be considered for the tests is the one calculated in 5.4.

The liquid used for the tests can be different from the one used in operation.

These tests shall be carried out on a tank which is considered as representative of a range of tanks by agreement between purchaser and supplier.

NOTE Use of water when non active part in the tank, is recommended to carry out the tests avoiding pollution or accident in case of leakage of liquid.

5.5.2 Measurement of pressure range

The increase or decrease of the liquid volume as calculated in 5.3 shall be added to or extracted from the relaxed tank, and the corresponding overpressure (P+) and under pressure (P-) shall be registered by a pressure device connected to the tank cover.

The liquid temperature of the transformer is stabilized at the ambient temperature of the laboratory which may differ from the filling temperature. This stabilization changes the pressure inside the transformer: in summer the pressure increases and in winter the pressure decreases in general. The liquid temperature during the measurement shall be the same value as used for sealing ± 3 K as described in the paragraph above. To maintain this tolerance of ± 3 K and then to have the real condition for the test with the atmospheric pressure inside the transformer, a small quantity of oil should be added or eliminated from the tank of the transformer during the test.

5.5.3 Endurance test

To simulate the volume expansion, the tank shall be subjected to 2 000 cycles with overpressure and under pressure. Each cycle comprises one overpressure and one under pressure. To achieve the overpressure and under pressure, the volume of liquid calculated in 5.4 shall be added to and extracted from the tank. The pressure P+ and P- shall be recorded during the test at intervals.

For the evaluation of the test (5.5.5 last line), the reading of the pressure device with the tank relaxed shall be recorded before (P0) and after the test (P1) and the tank shall be topped up with liquid to reach the initial relaxing pressure P0. If requested for the test evaluation, the added volume shall be recorded. The value of added volume shall be corrected by the difference between ambient temperature at the beginning and the end of the test.

If pauses are needed, it has to be implemented at sealing pressure to avoid to affect the result of the test.

To avoid mechanical impulses, the test duration may not be too short. A minimum cycle duration of 120 s may be sufficient.

5.5.4 Leakage test

After the endurance test, the same tank shall be subjected to a 24 h static leakage test with an overpressure 1,2 times the maximum value recorded during the endurance test.

5.5.5 Evaluation of the tests

After leakage test, the following events shall be observed:

— the tank shall not show leakages as observed by appropriate detecting means;(visual inspection or by application of fluorescent product sprayed on the tank…);

— no cracks shall occur in the tank;

— heavy and unexplained discrepancies on the pressure readings taken before, during and after the tests under measurement of pressure range and endurance test, have to be considered as possible indexes of abnormal events;

— by agreement between manufacturer and purchaser, a limit for the volume of liquid to be added at the end of the test may be specified for checking the permanent deformations of the tank.

6 Method of measurement of losses on double LV windings

6.1 Introduction

IEC 60076-8 is a general application guide that allows to determine the losses for some combinations of winding. The part of this standard allows to have a standardization method to measure the losses for the transformers having one HV winding and two LV windings.

6.2 Limits of this method

This method applies only for transformers with three windings, one HV winding and two LV windings. The two LV windings have identical voltage value and rated power. To apply this method the maximum difference between the impedance HV/LV1 and HV/LV2 cannot exceed 20 %.

For transformers that have two LV windings with non-identical voltage value or non-identical rated power or with a difference between impedance HV/LV1 and HV/LV2 exceeding 20 % then the full method of IEC 60076-8 applies.

NOTE This case of two LV windings with identical voltage value and rated power is often related to solar application.

6.3 Resistance measurement

See EN 60076-1:2011, 11.2.1 and 11.2.2.

6.4 Measurement of load losses and short circuit impedance

See EN 60076-1:2011, 11.2.2,11.2.3,11.4 and EN IEC 60076-11:2018,[1] 14.2.3 for the process of measurement.

The load losses measurement Pk is carried out by supplying HV with LV1 and LV2 in short-circuit.

The copper or aluminium bars used for short circuit shall have at least the same section as conductor to avoid extra-losses.

NOTE Additional measurements can be requested by the customers with the following different combinations.

- The separate values of short circuit impedance HV with one individual LV are measured in this way:
- Supply on HV, LV1 is in short-circuit, LV2 is opened ($P_{HV,LV1}$) to get the short circuit impedance between HV and LV1.
- Supply on HV, LV1 is opened, LV2 is in short circuit ($P_{HV,LV2}$) to get the short circuit impedance between HV and LV2.

LV 1 to LV2 value of short circuit impedance to get values between individual LV and assess the coupling of LV's is measured this way:

- Supply on one of the LV's (LV1 or LV2), short-circuiting the other LV (LV2 or LV1), HV open to get ($P_{LV1,LV2}$) the short circuit impedance between LV1 and LV2.