SLOVENSKI STANDARD
SIST EN 50216-9:2009

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Armature močnostnih transformatorjev in dušilk - 9. del: Toplotni izmenjevalnik olje-voda

Power transformer and reactor fittings - Part 9: Oil-to-water heat exchanger

Zubehör für Transformatoren und Drosselspulen - Teil 9: Öl-Wasser-Kühler

Accessoires pour transformateurs de puissance et bobines d'inductance - Partie 9: Echangeur thermique huile-eau

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Central Secretariat: avenue Marnix 17, B - 1000 Brussels

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 14, Power transformers.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50216-9 on 2008-10-21.

This European Standard is to be read in conjunction with EN 50216-1:2002, *Power transformer and reactor fittings - Part 1: General*.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2009-11-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2011-11-01

Contents

1 Scope

EN 50216-9 deals with oil-to-water heat exchangers that means a heat exchanger for the cooling of the transformer oil using a forced oil circuit and a forced water circuit.

The oil-side of the oil-to-water heat exchangers is not included in the scope of the Pressure Equipment Directive 97/23/EC according to Article 1, § 3.12. The water-side falls into Article 3, § 3 of the Pressure Equipment Directive, therefore the rating plate must not contain a CE sign according to Article 15 of the Pressure Equipment Directive.

This standard establishes essential dimensions and the requirements to ensure interchangeability and adequate mounting of the oil-to-water heat exchangers.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendment) applies.

EN 50216-1:2002	Power transformers and reactor fittings - Part 1: General
EN 60296	Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear (IEC 60296)
EN 60721-3-4	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 4: Stationary use at non-weatherprotected locations (IEC 60721-3-4)
EN 1092-1	Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories , PN designated - Part 1: Steel flanges
EN 1561	Founding - Grey cast irons
EN 1653	Copper and copper alloys - Plate, sheet and circles for boilers, pressure vessels and hot water storage units
EN 10025:1990 [1)]	Hot rolled products of non-alloy structural steels - Technical delivery conditions
EN 10027-2	Designation systems for steels - Part 2: Numerical system
EN 10088-2	Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes
EN 10130	Cold rolled low carbon steel flat products for cold forming - Technical delivery conditions
EN 12451	Copper and copper alloys - Seamless, round tubes for heat exchangers
EN 12452	Copper and copper alloys - Rolled, finned, seamless tubes for heat exchangers
EN 12502-1	Protection of metallic materials against corrosion - Guidance on the assessment of corrosion likelihood in water distribution and storage systems - Part 1: General
EN ISO 3506-1	Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs (ISO 3506-1)
ISO 4406	Hydraulic fluid power - Fluids - Methods for coding the level of contamination by solid particles

1) Replaced by EN 10025 series, Hot rolled products of structural steels.

3 Definitions

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

3.1
single tube
tube conducting the water in the oil filled compartment, either plain tubes which have the inner water side and the outer oil side with plain surface or finned tubes which have the outer oil side finned for increasing the heat transfer area from oil to tube

3.2
double tube
consists of two telescope tubes without blocking fluid. The inner water side of the inside tube is a plain tube. The outer oil side of the outside tube is either a plain tube or a finned tube. The inner side of the outside tube or the outer side of the inside tube has regularly groves for the leakage detection

3.3
tube bundle
number of parallel tubes to get the adequate heat transfer surface and the appropriate plates

3.4
single tube arrangement
the heat exchange from oil to water is conducted with a bundle of single tubes. For safety reasons of the transformer the oil pressure outside the tubes must always have a higher value than the water pressure inside the tubes, so that even in the case of heat exchanger untightness no water penetrates into the transformer oil

3.5
double tube arrangement
the heat exchange from oil to water is conducted with a bundle of double tubes. The double tube system has sufficient security for the transformer. The oil pressure outside the tubes may be less than the water pressure inside the tubes

3.6
tube plate
the cooling tubes are rolled or welded oil-tight and/or water-tight on both ends into the plates - for double tubes one end into two plates, for single tubes into one plate. With the tube plates the oil side is tightened against the water side

3.7
water channel
the water side of the heat exchanger is connected via the water channels

3.8
leakage detection
due to a leakage oil or water in the space between the double tubes would be detected

4 Requirements

4.1 Rated values

Values for inquiry (minimum):

- single tube / double tube heat exchanger		
- water quality (see A.6)		
- rated cooling capacity	Q_r	kW
- water temperature at inlet	t_1’	°C
- water temperature at outlet (max.)	t_1’’	°C
- average oil temperature	t_{2m}	°C
- oil temperature difference (min. value/max. value)	Δt_2	K
- water flow quantity (max.)	V_1	m³/h
- max. operating pressure (water side)	p_1	kPa

For an order the following rated values should be fixed:

- single tube / double tube heat exchanger
- materials
- rated cooling capacity Q_r kW
- rated water flow quantity V_1 m³/h
- rated oil flow quantity V_2 m³/h
- water temperature at inlet t_1' °C
- water temperature at outlet t_1'' °C
- oil temperature at inlet t_2' °C
- oil temperature at outlet t_2'' °C
- water side pressure drop Δp_1 kPa
- oil side pressure drop Δp_2 kPa
- max. operating pressure (water side) p_1 kPa
- max. operating pressure (oil side) p_2 kPa

4.2 Rated cooling capacity

The rated cooling capacity of the heat exchanger is the minimum capacity, which the manufacturer has to guarantee. For a heat exchanger in new condition the value is based on the following:

- rated water and oil flow quantities in connection with the particular permitted static pressure drops;
- oil-to-water heat exchangers must be designed with a capacity margin of min. 25 %.

For new heat exchangers the capacity with the margin has to be achieved with the rated values for oil flow quantity, water flow quantity, oil temperature at inlet and water temperature at inlet.

4.3 Mechanical design

The mechanical design is based on the ambient conditions according to EN 50216-1, Clause 3, and on a maximum oil temperature of 100 °C and a maximum water temperature of 50 °C. Deviating temperatures and ambient conditions as well as other insulating fluids must be agreed between manufacturer and purchaser.

The cooling tubes and plates are oil tight and water tight connected. The tube bundle could expect the following execution (execution be agreed between manufacturer and purchaser):

- one side with floating head cover, the bundle can be pulled out;
- fixed tube plate and stationary heads.

The water channels are removable and can separately be emptied. Removing of a water channel must not influence the oil circuit.

On the oil-side the heat exchanger must be vacuum proof.

The heat exchanger has to be designed for unprotected outdoor installation. The heat exchanger must be completely drainable and ventable on the oil side and on the water side.

For material selection criteria refer to A.6.

The maximum permissible oil pressure in service for the heat exchanger is limited to 350 kPa.

The maximum permissible water pressure in service for heat exchanger with single tubes is limited to 340 kPa.

The maximum permissible water pressure in service for heat exchanger with double tubes is limited to 800 kPa [2)].

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2) For higher water pressure in service, design and test values must be enlarged adequate and the rules of PED 97/23/EC must be followed.

4.4 Corrosion protection

Common screws and nuts: Stainless steel according to EN ISO 3506-1.

4.4.1 Inner surface water side (standard)

Water channels are protected with epoxy coating. Thickness minimum 150 µm or according to special agreement.

Several selections are given in Table A.2.

4.4.2 Inner surface oil side (standard)

Oil resistant protection, minimum resistant for 100 °C [3] temperature.

4.4.3 Outer surface

Corrosion protection and coating must be agreed between manufacturer and purchaser. The required environmental conditions must be followed.

The severities of the environmental conditions are classified in EN 60721-3-4.

5 Designation

5.1 Designation of the heat exchangers

The following oil-to-water heat exchangers are differentiated:

- single tube arrangements

Type	OWSA	oil-water heat exchanger with single tubes, vertical suspensory type
Type	OWSB	oil-water heat exchanger with single tubes, horizontal type
Type	OWSC	oil-water heat exchanger with single tubes, vertical standing type

- double tube arrangements

Type	OWDA	oil-water heat exchanger with double tubes, vertical suspensory type
Type	OWDB	oil-water heat exchanger with double tubes, horizontal type
Type	OWDC	oil-water heat exchanger with double tubes, vertical standing type

EXAMPLE for designation:

oil-water heat exchangers with double tubes, vertical standing type (OWDC),
rated capacity 250 kW (250), top oil temperature rise 43 K (43), form D,

Heat exchanger EN 50216-9–OWDC–250/43–D

5.2 Rating plate information

The rating plate must have the following information and has to be attached clearly readable on the assembled heat exchangers:

- sign or name of supplier;
- designation according to EN 50216-9, 5.1;
- serial number;
- manufacturing year.

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[3] Deviations in the temperature must be agreed between manufacturer and purchaser.

Rated values:

- rated capacity in kW;
- rated oil- and water-flow quantity in m³/h;
- min./max. operating water flow quantity in m³/h;
- inlet and outlet temperatures oil-side and water-side in °C;
- pressure drop in the heat exchanger oil side/water side in bar;
- max. pressure in service for oil-side in kPa;
- max. pressure in service for water-side in kPa;
- max. design temperature for oil-side in °C;
- min. ambient temperature (water-side completely empty) in °C;
- mass of heat exchanger without oil and water in kg;
- oil and water quantity for filling in dm³.

Rating plate material: corrosion resistant and acid proof
(other versions of the rating plate upon agreement)

6 Tests

6.1 Routine tests

6.1.1 Tightness tests

6.1.1.1 Tightness test oil side

The oil side of the oil-to-water heat exchanger has to be filled with transformer oil with the temperature of (60 ± 5) °C and a pressure of 500 kPa. After deletion of the last leakage the test pressure must be performed for a period of 6 h without any leakage (visual inspection).

The oil side of the oil-to-water heat exchanger may be submitted to the following alternative tightness tests by agreement between manufacturer and purchaser:

- hydraulic test with transformer oil filled at ambient temperature and pressure of 500 kPa for 3 h;
- pneumatic test with compressed air under water at 500 kPa for 2 h.
  For the above mentioned period no leakage (by visual inspection) has to be detected.

6.1.1.2 Tightness test water side

6.1.1.2.1 Single tube arrangement

The water side of the oil-to-water heat exchanger with single tubes has to be filled with eased water (drinking quality) under a pressure of 500 kPa. After deletion of the last leakage the test pressure must be performed for a period of 2 h without any leakage.

The water side of the oil-to-water heat exchanger with single tubes may be submitted to the following alternative tightness tests by agreement between manufacturer and purchaser:

- pneumatic test with compressed air under water at 500 kPa for 2 h.
  For the above mentioned period no leakage (by visual inspection) has to be detected.

6.1.1.2.2 Double tube arrangement

The water side of the oil-to-water heat exchanger with double tubes has to be filled with eased water (drinking quality) under a pressure of 1 200 kPa [4]. After deletion of the last leakage the test pressure must be performed for a period of 2 h without any leakage.

The water side of the oil-to-water heat exchanger with double tubes may be submitted to the following alternative tightness tests by agreement between manufacturer and purchaser:

- pneumatic test with compressed air under water at 1 200 kPa for 2 h.
  For the above mentioned period no leakage (by visual inspection) has to be detected.

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[4] For higher water pressure in service, design and test values must be enlarged adequate and the rules of PED 97/23/EC must be followed.

6.1.2 Visual inspection of the surfaces

6.1.2.1 Outside surface

Visual the surfaces shall be free of damages, deformations and dirt. Every sort of filling compounds shall not be used.

6.1.2.2 Inside surface oil side

Visual the surfaces shall be free of damages, deformations and dirt. Oil side the heat exchanger shall be flushed with transformer oil via micron filter until size and amount of particles is less than the agreed limited value. The flushing oil shall be in accordance to EN 60296. During flushing the oil flow velocity shall be sufficient. Thereupon the heat exchanger is ready to operate. Number and size of particles, as well as particle test procedure and flushing velocity or other cleaning criteria (e.g. according to ISO 4406) have to be agreed.

6.1.2.3 Inside surface water side

Visual the surfaces shall be free of damages, deformations and dirt.

6.2 Type tests

6.2.1 Test of the rated values

Usually this test is performed together with the transformer. Separate type tests should be fixed by a special agreement between supplier and purchaser.

6.2.2 Test of the outside painting

The layer thickness of each single layer shall be in accordance with the purchase specification. Works inspection or another suitable inspection can be agreed between purchaser and manufacturer in relation to the surface protection according to 4.4.

7 Preparation for transport and storage

The oil has to be drained completely after flushing with transformer oil via micron filter. All flange openings shall be closed using blind flanges. As an option, on purchaser demand, the heat exchanger shall be filled under an overpressure of approximate 30 kPa with nitrogen or synthetic air (humidity less than 10 %) using a valve installed in one of the blind flanges. For long-term storage, that has to be indicated by the purchaser, the overpressure must remain minimum 5 kPa and therefore has to be checked regularly.

After flushing with fresh water the heat exchanger must be completely emptied.

Water side flanges, thread holes for water side venting and thermometer pockets have to be protected against penetration of subjects.

8 Mounting and service, service conditions

Free water run-out at heat exchanger outlet shall be assured for single tube arrangements. The oil-side pressure must be always higher than the water-side pressure for single tube arrangements. The water-side pressure shall be limited with suitable arrangements.

Heat exchanger, which are not in service, shall be completely drained, cleaned, dried and closed.

The heat exchanger should be controlled periodically on the water-side in dependence on the water quality and cleaned if necessary.

Insoluble impurities, especially suspended solids will cause short cleaning periods. This could be avoided e.g. when using screens or filters.

Min. water-flow volume for guidance: approx. 80 % of rated water-flow volume

Max. water-flow volume for guidance: approx. 110 % of rated water-flow volume

Thze above mentioned regulation is valid without any consideration of the tube material. The extension of a.m. limitations for min, and max. water flow volume has to be checked carefully especially under consideration of the max. allowable water velocity and pressure.