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Toplotni sončni sistemi in sestavni deli - Industrijsko izdelani sistemi - 2. del: Preskusne metode

Thermal solar systems and components - Factory made systems - Part 2: test methods

Thermische Solaranlagen und ihre Bauteile - Vorgefertigte Anlagen - Teil 2: Prüfverfahren

Installations solaires thermiques et leurs composants - Installations préfabriquées en usine - Partie 2: Méthodes d’essai

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Installations solaires thermiques et leurs composants - Installations préfabriquées en usine - Partie 2: Méthodes d'essai

Thermische Solaranlagen und ihre Bauteile - Vorgefertigte Anlagen - Teil 2: Prüfverfahren

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 312.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This European Standard (EN 12976-2:2014) has been prepared by Technical Committee CEN/TC 312 “Thermal solar systems and components”, the secretariat of which is held by ELOT.

This European Standard will supersede EN 12976-2:2006.

Introduction

Drinking water quality

In respect of potential adverse effects on the quality of water intended for human consumption, caused by the product covered by this standard:

a) This standard provides no information as to whether the product may be used without restriction in any of the Member States of the EU or EFTA;

b) It should be noted that, while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

Factory Made and Custom Built solar heating systems

The standards EN 12976-1, EN 12976-2 EN 12977-1:2012, EN 12977-2:2012, EN 12977-3, EN 12977-4:2012 and EN 12977-5:2012 distinguish two categories of solar heating systems: **Factory Made** solar heating systems and **Custom Built** solar heating systems. The classification of a system as Factory Made or Custom Built is a choice of the final supplier, in accordance with the following definitions:

Factory Made solar heating systems are batch products with one trade name, sold as complete and ready to install kits, with fixed configurations. Systems of this category are considered as a single product and assessed as a whole.

If a Factory Made Solar Heating System is modified by changing its configuration or by changing one or more of its components, the modified system is considered as a new system for which a new test report is necessary. Requirements and test methods for Factory Made solar heating systems are given in EN 12976-1 and EN 12976-2.

Custom Built solar heating systems are either uniquely built, or assembled by choosing from an assortment of components. Systems of this category are regarded as a set of components. The components are separately tested and test results are integrated to an assessment of the whole system. Requirements for Custom Built solar heating systems are given in EN 12977-1:2012; test methods are specified in EN 12977-2:2012, EN 12977-3, EN 12977-4:2012 and EN 12977-5:2012.

Custom Built solar heating systems are subdivided into two categories:

- **Large Custom Built systems** are uniquely designed for a specific situation. In general HVAC engineers, manufacturers or other experts design them.

- **Small Custom Built systems** offered by a company are described in a so-called assortment file, in which all components and possible system configurations, marketed by the company, are specified. Each possible combination of a system configuration with components from the assortment is considered as **one** Custom Built system.

Table 1 shows the division for different system types:

Table 1 - Division for factory made and custom built solar heating systems

Factory Made Solar Heating Systems (EN 12976-1:2006 and EN 12976-2:2006)	Custom Built Solar Heating Systems (EN 12977-1:2012, EN 12977-2:2012 and EN 12977-3)
Integral collector storage systems for domestic hot water preparation	Forced-circulation systems for hot water preparation and/or space heating, assembled using components
Thermosiphon systems for domestic hot water preparation	and configurations described in an assortment file (mostly small systems)
Forced-circulation systems as batch product with fixed configuration for domestic hot water preparation	Uniquely designed and assembled systems for hot water preparation and/or space heating (mostly large systems)

NOTE 1 Forced circulation systems can be classified either as Factory Made or as Custom Built, depending on the market approach chosen by the final supplier.

NOTE 2 Both Factory Made and Custom Built systems are performance tested under the same set of reference conditions as specified in Annex B of the present standard and Annex A of EN 12977-2:2012. In practice, the installation conditions may differ from these reference conditions.

NOTE 3 A Factory Made system for domestic hot water preparation may have an option for space heating, however this option should not be used or considered during testing as a Factory Made system.

1 Scope

This European Standard specifies test methods for validating the requirements for Factory Made Thermal Solar Heating Systems as specified in EN 12976-1. The standard also includes two test methods for thermal performance characterization by means of whole system testing.

2 Normative references

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

ISO 9806, *Thermal solar systems and components – Factory made systems – Part 2: Test methods*

EN 12976-1:2006, *Thermal solar systems and components - Factory made systems – Part 1: General requirements*

EN 12977-2:2012, *Thermal solar systems and components — Custom built systems — Part 2: Test methods*

EN 60335-1, *Household and similar electrical appliances - Safety - Part 1: General requirements (IEC 60335-1:2001, modified)*

EN 60335-2-21, *Household and similar electrical appliances - Safety - Part 2-21: Particular requirements for storage water heaters (IEC 60335-2-21:2002, modified)*

EN ISO 9488:1999, *Solar energy – Vocabulary (ISO 9488:1999)*

ISO 9459-1:1993, *Solar heating - Domestic water heating systems - Part 1: Performance rating procedure using indoor test methods*

ISO 9459-2:1995, *Solar heating – Domestic water heating systems – Part 2: Outdoor test methods for system performance characterization and yearly performance prediction of solar-only systems*

ISO 9459-5:2007, *Solar heating – Domestic water heating systems – Part 5: System performance characterization by means of whole-system tests and computer simulation*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN ISO 9488:1999 and EN 12976-1:2006 apply.

4 Symbols and abbreviations

$Q_{aux, net}$ net auxiliary energy demand of a solar heating system delivered by the auxiliary heater to the store or directly to the distribution system (see 5.8.3.2)

Q_d heat demand

Q_L energy delivered at the outlet of the solar heating system

Q_{par} parasitic energy (electricity) for the collector loop pump(s) and control unit

H_c hemispherical solar irradiation in the collector plane

Q_l store heat loss

Q_{ohp} heat diverted from the store as active overheating protection, if any

Q_{sol} heat delivered by the collector loop to the store

5 Testing

5.1 Freeze resistance

5.1.1 General

The following checks are given to ensure that the protective anti-freezing provisions are operating properly. There are many possible forms of protective provisions, and the testing authority shall first identify which method has been employed.

The provision shall then be checked in accordance with the appropriate section of the following list (see 5.1.2 to 5.1.6) in accordance with the manufacturer's recommendations.

5.1.2 Systems using antifreeze fluid

The system components which are exposed to low ambient temperature are filled with an antifreeze fluid, usually a glycol/water mixture, having a low enough freezing point. For thermo-siphon systems declared as freeze resistant down to a specific temperature, one possible test procedure described in AS/NZS 2712 is recommended. This procedure could also be adapted to other systems containing pure water. So far, electrical heater for freeze protection won't be tested for suitability.

For these systems, no freezing test is performed. However, if no sufficient data is available on the freezing point of the antifreeze fluid, the freezing point shall be measured and checked against the minimum system temperature as given by the manufacturer.

NOTE In general, the minimum allowed temperature of the system is equal to the freezing point of the antifreeze fluid. If the concentration of some antifreeze fluids - like glycol's - exceeds a certain limit, they can freeze without damaging the system. In this case the minimum allowed temperature can be lower than the freezing point of the antifreeze fluid.

Check the freezing point by measuring the glycol concentration (e.g. using a portable refractometer) before and after the over temperature protection test (5.2). The freezing point shall not differ more than 2 °K.from the value recommended by the manufacturer in agreement with the local climate (minimum expected air temperature, radiative cooling of the collectors).

The composition of the fluid shall be checked to see whether it is in accordance with the manufacturer's specifications.

5.1.3 Drain-back systems

When freezing danger occurs, the fluid in the system components that is exposed to low ambient temperature, is drained into a storage vessel for subsequent reuse.

The collector loop piping should be in accordance with the manufacturer's recommendations in the installer manual and if there is no instruction, according to reference conditions given in Annex B.

Filling may be observed from the pressure gauge or from water level indicator. Switch the pump on, and observe the pressure gauge or water level indicator. If the system does not include a pressure gauge or level indicator, other means for checking filling provided by the manufacturer shall be used in accordance with the instruction manual.

Drain-back may be observed from the decreasing reading of the pressure gauge or water level indicator. Switch the pump OFF, and observe the pressure gauge or water level indicator. If the system does not include a pressure gauge or level indicator, other means for checking drain-back provided by the manufacturer shall be used in accordance with the instruction manual.

A system in which components and/or piping are subject to damage by freezing shall have the proper fittings, pipe slope and collector design to allow for manual gravity draining and air filling of the affected components and piping. Pipe slope for gravity draining shall be as the manufacturer recommendation or shall have a minimum 2 cm vertical drop for each meter of horizontal length. This also applies to any header pipes or absorber plate riser tubes internal to the collector.

5.1.4 Drain-down systems

The fluid in the system components, which are exposed to low ambient temperature, is drained and run to waste when freezing danger occurs.

To perform checks of the drain-down function the collector loop piping should be in accordance with the manufacturer's recommendations in the installer manual and if there is no instruction, according to reference conditions given in Annex B.

In most cases the systems are equipped with a drain-down valve at the bottom and a vacuum relief valve at the top of the fluid circuit.

The proper opening and closing of the vacuum relief valve shall be checked during drain-down operation and after re-filling the system.

If there is a solenoid drain valve independent of the control unit, simulate the opening temperature.

If there is a non-electrically operated freeze-protection valve, a check can be made using a freezing spray. The temperature-sensing element shall be sprayed. The measured temperature of the valve opening is to be compared with the nominal value given by the manufacturer. It is important that the sensing part of the freeze-protection valve be properly placed.

If the system uses an electrically operated freeze-protection valve, drain down shall be checked while interrupting the power.

The drain-down rate shall be measured (e.g. by using a vessel and a stop-watch) and documented during drain-down operation.

5.1.5 Freeze protection and control functions combined

For systems where the freeze-protection and control functions are combined, the control unit shall be checked as follows:

Set the simulated temperature of the freeze-protection sensor to a value deactivating the freeze protection. Decrease the simulated temperature slowly. Measure the temperature $T_{\text{FP (freeze-protection)}}$ of the related actuator. Compare it with the nominal value given by the manufacturer.

5.1.6 Other systems

For all other systems, the pump control system, drain-down valve or any other freeze protection device or system shall be checked to the manufacturer's specification and the minimum allowed temperature specified by the manufacturer.

For ICS systems, or other SDHW systems with the tank placed outside, special frost resistance tests should be carried out, as described in C.1.

5.2 Over temperature protection

5.2.1 Purpose

The purpose of this test is to determine whether the solar water heating system is protected against damage and the user is protected from scalding hot water delivery after a period of no hot water draw and failure of electrical power.

5.2.2 Apparatus

The following apparatus is required:

a) A pyranometer having the minimum characteristics specified in ISO 9806, to measure the total short wave radiation from both the sun and the sky or the short wave radiation from a solar simulator lamp if the test is to be conducted inside a solar simulation chamber.

b) Equipment to measure the temperature, flow rate and volume of hot water drawn from the system.

c) An outdoor or an indoor test stand for installing the solar hot water system with the collector array at the manufacturer's specified tilt angle.

d) A temperature and pressure controlled water supply within the range of 5°C to 25 ºC and 200kPa to 600 kPa or the manufacturer's maximum working pressure whichever is less.

This test may be conducted using a solar simulator or outdoors.

5.2.3 Procedure

The system, both as described in the installation manual and as installed on the test facility, shall be first checked on overheating safety, e.g. if safety valves and other overheating protection devices are present and installed at the right place, if there are no valves between components and relief valves etc. For systems containing antifreeze fluids, it shall be checked whether sufficient precautions have been taken to prevent the antifreeze fluid from deterioration as a result of high temperature conditions (See also 5.6).

Furthermore, if non-metallic materials are used in any circuit, the highest temperature in the circuit shall be measured during the over temperature protection test, for use in the pressure resistance test.

The procedure of testing shall be as follows:

a) Assemble the solar water heating system according to the installation instructions with the collector array oriented towards solar noon for the outdoor test, or the simulator lamp may be adjusted to normal incidence for the indoor test.

b) Charge the system from the water supply and, for pressurized storage tanks, maintain the water supply pressure.

c) Energize the system as per installation instructions.

d) (i) For the outdoor test, operate the system for a minimum of 4 consecutive days without any hot water withdrawal and until the collector array has been subjected to 2 consecutive days in which the solar irradiation on the plane of the collector array has exceeded 20 MJ/m^2 per day and the ambient temperature has exceeded 20 ºC during solar noon.

(ii) For the indoor test, operate the system without any hot water withdrawal at an ambient temperature of (25 ± 2) ºC and a minimum solar lamp irradiance of 1000 W/m^2 at the plane of the collector array, measured and with a uniformity as specified in ISO 9459-1:1993, 6.3.1.2 for a 5 h period or until the collector array drains.

e) (i) For the outdoor test, disconnect all electrical power (if there is any) to the system and continue to operate the system until the solar irradiation on the plane of the collector array has exceeded 20 MJ/m^2 per day or until the load circuit drains.

(ii) For the indoor test, disconnect all electrical power to the system and subject the system to a solar lamp irradiance of 1000 W/m^2 at the plane of the collector array for an additional 4 h or until the collector array drains.

f) Immediately begin to withdraw a volume of water greater than the total volume of water in the system at a rate of $2x10^{-4} \pm 3x10^{-5}$ m^3/s (10 ± 1 L/min.)

5.2.4 Reporting requirements

The following results shall be reported:

a) The make and model identification of the system including ancillary scald and over temperature protection devices fitted as well as a physical description of how over temperature protection should work according to the manufacture’s documentation.

b) The inclination of the collector array.

c) A record of temperature of the hot water withdrawn from the system versus time and the total volume of water withdrawn. Note the presence of steam if observed.

d) Details of the condition of the system and individual components following the test or any failure modes during the test with particular regard to any defects which may affect the serviceability of the system such as the swelling of pipes and components or fluid leakages.

5.3 Pressure resistance

5.3.1 Purpose

The purpose of this test is to evaluate hydraulic pressure rating of all components and interconnections of a solar water heating system when installed according to the manufacturer's instructions.

5.3.2 Apparatus

The apparatus shall consist of the following:

a) suitable platform and support structure for installation of the system

b) pressure regulated hydraulic pressure source

c) pressure gauge suitable to determine the test pressure to within 5 %

d) bleed valve

e) isolation valve

5.3.3 Safety precaution

An explosion safe enclosure is recommended when testing systems that have an integral expansion space or tank that contains entrapped air.

5.3.4 Procedure

The system, both as described in the installation manual and as installed on the test facility, shall be first checked on pressure safety, e.g. if safety valves and other overheating protection devices are present and installed at the right place, if there are no valves between components and relief valves etc.

The duration of the test is 15 min. If a non-metallic material is used in any circuit, this procedure has to be applied after performing the “over Temperature protection” test (see 5.2).

a) Install the solar water heating system on the test platform in accordance with the manufacturer's instructions.

b) Disable the pressure relief valves, if applicable, to prevent their opening during testing.

c) Connect the isolation valves to the (lower) fill ports of each circuit of the system

d) Fill all circuits in the order described in the manufacturer’s installer manual using the required fluid for each circuit. If no information about the fill procedure is provided in the manual, the inner circuits should be filled first. After filling the upper port of each circuit should remain open to provide pressure balance with the ambient pressure.

e) Perform the pressure tests of the circuits of the system in the same order as they have to be pressurized (or installed) according to the manufacturer’s installer manual. If no installation order is given by the manufacturer, perform the pressure tests of the internal heat transfer loops (and other internal vessels) first.

f) For testing of each independent loop follow the steps listed below:
   1. Connect the bleed valve and pressure gauge to the (upper) drain port of the heat transfer loop.
   2. Connect the hydraulic pressure source to the fill port of the tested heat transfer circuit.
   3. Bleed all air, as far as possible, out of the loop through the bleed valve at the drain port.
   4. Apply a hydraulic pressure equal to 1.5 times the manufacturer's stated maximum individual working pressures.
   5. Isolate the pressure source by closing the isolation valve and record the readings of the pressure gauge at the beginning and end of the next 15 min interval.
   6. Release the pressure through the bleed valve and record any visible permanent deformation and heat transfer fluid leakage from system components and interconnections.
   7. Disconnect the hydraulic pressure source from the fill port, the bleed valve and pressure gauge from the drain port and leave the circuit filled and opened at the ambient pressure.
   8. Repeat the steps 1)-7) until all circuits have been tested.

g) Empty all circuits in the reversed fill order or according to emptying instructions contained in the manufacturer’s installer manual if present.

h) Disconnect all isolation valves from the system.

5.3.5 Reporting requirements

Report the maximum test pressures applied, the pressure readings at the beginning and end of the 15 min test intervals and any visible permanent deformation or leakage from system components and interconnections. Note if the applied test pressures are lower than 1,5 times the manufacturer's stated maximum working pressure.

The test may be considered as passed, if the pressure drop during the test period does not exceed more than 5% of the test pressure.

5.4 Water contamination

Check if the documentation for the installer includes instructions for the installation of the adequate means for preventing backflow from all circuits to drinking main supplies.

A method for analysing the risks in the use point and election of the suitable protection is described in EN-1717:2000.

Step1 - Determination of the fluid categories that could be in contact with potable water. First of all determine the number of hydraulic circuits to protect in the factory made system. Primary circuit or collector loop: The working fluid can be water with antifreeze protection.

According to the Table B.1 Annex B of the EN-1717:2000, antifreeze protection is fluid category 3.
Secondary circuit or consumer loop: The working domestic hot water (DHW). According to the Table B.1 Annex B of the EN-1717:2000, DHW is fluid category 2

Category 1: Water to be used for human consumption coming directly from a potable water distribution system.
Category 2: Fluid presenting no human health hazard. Fluid recognized as being fit for human consumption. , including water taken from a potable water distribution system, which can have undergone a change in taste, odour, colour or a temperature change (heating or cooling).
Category 3: Fluid representing some human health hazard due to the presence of one or more harmful substances.
Category 4: Fluid representing a human health hazard due to the presence of one or more toxic or very toxic substances or one or more radioactive, mutagenic or carcinogenic substances.
Category 5: Fluid presenting a human health hazard due to the presence of microbiological or viral elements.
Outcome: List containing the fluid category of each loop

Step 2 - Check the separation between collector loop and consumer loop. Check that the separation between collector and consumer loop of the solar thermal system according to the fluid category is at least a wall. Category 2 and 3 fluids may be separated from potable water by a single wall, while a single wall is not sufficient for category 4 and 5 fluids. A double wall with a safety medium in between (liquid or gas) and an acoustical or visual alarm system is required when the fluid from which the potable water shall be protected against is of category 4 or 5.

Step 3 - Air opening for drain. Check that the factory made system have open air outlets before draining to the building drain system.

Outcome: TRUE/FALSE

Step 4 - Installation features. Check the pressure on the connection point between the system and the mains water network.
P = atm
P > atm
Step 5 - Determination of the protection units for the mains water network connection point suitable for the fluid category.

Conclusion:
According to the Table 2 of the EN-1717:2000, usually for factory made systems with DHW in the consumer loop it is enough to check that there is at least a reverse flow protection valve.
Outcome: reverse flow protection valve present? TRUE/FALSE

5.5 (New) Testing the resistance against mechanical load

5.5.1 Purpose

This test is used to evaluate the carrying capacity of a (thermosiphon) system due to snow and wind loads. The following procedure is for systems comprising a rack with a tilt angle where either the collector is separable or not separable from the tank. In both cases the whole system has to undergo a mechanical load test, not only for systems with not separable collectors as described in EN 12976 Chapter 4.3.1. The mechanical load test is adopting the procedure according to ISO 9806 Chapter 5.9.

5.5.2 Apparatus

- plane surface to put the system on
- sand sacks (stone plates…)
- measuring tape
- stop watch
- camera
- straps for keeping single weights in position

5.5.3 Safety precaution

- safety glasses
- safety shoes
- gloves
- long sleeved clothing and cap

5.5.4 Calculation procedure for the mechanical load

The requested pressure on the system is charged with sand sacks (or stone plates) and should be raised in 250 Pa steps until 1000 Pa.

To determine these four weights classes, to charge the system with, first of all the system area A_{sys} needs to be calculated.