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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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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

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

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 $T_{\mathrm{FP\ (freeze\text{-}protection)}}$ 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

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