SLOVENSKI STANDARD
SIST EN 12977-4:2012

01-julij-2012

Nadomešča:
SIST-TS CEN/TS 12977-4:2010

Toplotni sončni sistemi in sestavni deli - Neserijsko izdelani sistemi - 4. del: Preskusne metode delovanja sončnih zbiralnikov

Thermal solar systems and components - Custom built systems - Part 4: Performance test methods for solar combistores

Thermische Solaranlagen und ihre Bauteile - Kundenspezifisch gefertigte Anlagen - Teil 4: Leistungsprüfung von Warmwasserspeichern für Solaranlagen zur Trinkwassererwärmung und Raumheizung (Kombispeicher)

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Installations solaires thermiques et leurs composants - Installations assemblées à façon - Partie 4 : Méthodes d'essai pour chauffe-eau solaires et installations solaires combinées

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91.140.65	Oprema za ogrevanje vode	Water heating equipment

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EUROPEAN STANDARD

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English Version

Thermal solar systems and components - Custom built systems - Part 4: Performance test methods for solar combistores

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 12977-4:2012) has been prepared by Technical Committee CEN/TC 312 “Thermal sorla systems and components”, the secretariat of which is held by ELOT.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2012, and conflicting national standards shall be withdrawn at the latest by October 2012.

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Introduction

The test methods for stores of solar heating systems as described in this document are required for the determination of the thermal performance of small custom built systems for combined domestic hot water preparation and space heating, so-called solar combisystems, as specified in EN 12977-1.

These test methods deliver parameters, which are needed for the simulation of the thermal behaviour of a store being part of a small custom built system.

NOTE 1 With the test methods for stores given in EN 12897 only a few parameters are determined in order to characterise the thermal behaviour of a store. These few parameters are not sufficient for the determination of the thermal performance of small custom built systems as described in EN 12977-2.

NOTE 2 The already existing test methods for stores of conventional heating systems are not sufficient with regard to thermal solar systems. This is due to the fact that the performance of thermal solar systems depends much more on the thermal behaviour of the store (e.g. stratification, heat losses), as conventional systems do. Hence, this separate document for the performance characterisation of stores for solar heating systems is needed.

NOTE 3 For additional information about the test methods for the performance characterisation of stores see EN 12977-3 and [1] in Bibliography.

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1 Scope

This European Standard specifies test methods for the performance characterization of stores which are intended for use in small custom built systems as specified in EN 12977-1.

Stores tested according to this document are commonly used in solar combisystems. However, the thermal performance of all other thermal stores with water as a storage medium (e.g. for heat pump systems) can be also assessed according to the test methods specified in this document.

This document applies to combistores with a nominal volume up to 3 000 l and without integrated burner.

NOTE This document is extensively based on references to EN 12977-3:2012.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12828, *Heating systems in buildings — Design for water-based heating systems*

EN 12977-3:2012, *Thermal solar systems and components — Custom built systems — Part 3: Performance test methods for solar water heater stores*

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

3 Terms and definitions

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For the purposes of this document, the terms and definitions given in EN 12977-3:2012 and EN ISO 9488:1999 apply.

4 Symbols and abbreviations

For symbols and abbreviations, refer to EN 12977-3:2012.

5 Store classification

Solar combistores are classified by distinction between different charge and discharge modes. Five groups are defined as shown in Table 1.

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Table 1 — Classification of combistores

Group	Charge mode	Discharge mode
1	direct	direct
2	indirect	direct
3	direct	indirect
4	indirect	indirect
5	stores that cannot be assigned to groups 1 to 4	

NOTE 1 All stores may have one or more additional electrical heating elements.

NOTE 2 Stores that can be charged or discharged directly and indirectly (e.g. a store of a space heating system with an internal heat exchanger for the preparation of domestic hot water) can belong to more than one group. In this case, the appropriate test procedures or the assignment to one of the groups respectively, should be chosen depending on its mode of operation.

6 Laboratory store testing

6.1 Requirements on the testing stand

6.1.1 General

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The hot water store shall be tested separately from the whole solar system on a store-testing stand.

The testing stand configuration shall be determined by the classification of the combistores as described in Clause 5.

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An example of a representative hydraulic testing stand configuration is shown in EN 12977-3:2012, Figure 1 and Figure 2. An appropriate test facility consists of two charge loops as shown in EN 12977-3:2012, Figure 1 and two discharge loops as shown in EN 12977-3:2012, Figure 2.

6.1.2 Measuring data and measuring procedure

The requirements specified in EN 12977-3:2012, 6.1.2 shall be fulfilled.

6.2 Installation of the store

6.2.1 Mounting

The store shall be mounted on the testing stand according to the manufacturer's instructions.

The temperature sensors used for measuring the inlet and outlet temperatures of the fluid used for charging and discharging the storage device, shall be placed as near as possible at least 200 mm to the inlet and outlet connections of the storage device. The installation of the temperature sensors inside the pipes shall be done according to approved methods of measuring temperatures.

If there is/are more than one pair of charging and/or discharging inlet or outlet connections, then only one may be connected to the testing stand (at the same time) while the other(s) shall be closed.

The pipes between the store and the temperature sensors shall be insulated according to EN 12828.

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6.2.2 Connection

The way of connecting the storage device to the testing stand depends on the purpose of the thermal tests which shall be performed. Detailed instructions are given in the clauses where the thermal tests are described.

Connections of the store which do not lead to the charge or discharge circuit of the testing stand shall be closed, and not connected heat exchangers shall be filled up with water. All closed connections shall be insulated in the same way as the store.

Since fluid in closed heat exchangers expands with increasing temperature, a pressure relief valve shall be mounted.

NOTE The performance of a solar heating system depends on the individual installation and actual boundary conditions. With regard to the heat losses of the store besides deficits in the thermal insulation, badly designed connections can increase the heat loss capacity rate of the store due to natural convection that occurs internally in the pipe. In order to avoid this effect, the connections of the pipes should be designed in such a way that no natural convection inside the pipe occurs. This can be achieved if the pipe is directly going downwards after leaving the store or by using a heat trap siphon.

6.3 Test and evaluation procedures

6.3.1 General

The aim of store testing as specified in this document is to determine parameters required for the detailed description of the thermal behaviour of a hot water combistore. Therefore, a mathematical computer model for the store is necessary. The basic requirements on suitable models are specified in Annex A and Annex B.

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The following parameters shall be known for the simulation of a store being part of a solar system.

a) Stored water:

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1) height;

2) effective volume respectively effective thermal capacity;

3) heights of the inlet and outlet connections;

4) heat loss capacity rate of the entire store;

5) if the insulation varies for different heights of the store, the distribution of the heat loss capacity rate should be determined for the different parts of the store;

6) a parameter describing the degradation of thermal stratification during stand-by;

NOTE 1 One possible way to describe this effect in a store model is the use of a vertical thermal conduction. In this case, the corresponding parameter is an effective vertical thermal conductivity.

7) a parameter describing the characteristic of thermal stratification during direct discharge;

NOTE 2 An additional parameter may be used to describe the influence of different draw-off flow rates on the thermal stratification inside the store, if this effect is relevant.

8) positions of the temperature sensors (e.g. the sensors of the collector loop and auxiliary heater control).

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b) Heat exchangers:

1) heights of the inlet and outlet connections;

2) volume;

3) heat transfer capacity rate as a function of temperature;

4) information on the capacity in respect of stratified charging;

NOTE 3 The capacity in respect of stratified charging can be determined from the design of the heat exchanger as well as from the course in time of the heat exchanger inlet and outlet temperatures.

5) heat loss rate from the heat exchanger to the ambient (necessary only for mantled heat exchangers and external heat exchangers).

c) Electrical auxiliary heat source:

1) position in the store;

2) axis direction of heating element (horizontal or vertical). If the auxiliary heater is installed in a vertical way, also its length is required;

3) effectivity that characterises the fraction of the thermal converted electric power which is actually transferred inside the store.

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NOTE 4 Badly designed electrical auxiliary heaters may cause significant heat losses during operation. In this case, the electrical power supplied to the heater is not equal to the thermal energy input to the store.

The following clauses describe how the listed parameters can be determined. Therefore, specific test sequences are necessary. The test sequences indicated by letters (e.g. test CD) can be subdivided into phases indicated by a number (e.g. CD1 – conditioning). Between the end of one phase and the start of the following phase, a maximum stand-by time of 10 min is allowed. During this stand-by time, the ambient temperature only shall be measured and recorded.

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NOTE 5 One essential point of the methods described is that measurements inside the store are avoided.

NOTE 6 The determination of all above listed store parameters is possible only according to the method described in 6.3.2 and the data processing of the test sequences described in 6.3.3. For further details and test sequences, see EN 12977-3.

6.3.2 Test sequences

6.3.2.1 Introduction

The store is tested on the test stand by different specific test sequences. The sequences are specified to stimulate the physical effects, which correspond to the parameter to be determined. A parameter identification program using a store model evaluates the measuring data.

Charging and discharging the entire store implies connections of the charge/discharge circuits to the uppermost and lowermost direct ports available at the tank. Full discharging is required for conditioning of the store and for the final discharge phase. Full charging is required for all discharge tests, which require that the entire store is charged.

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The series of the performed tests should comprise two tests, which include stand-by periods. One test is for the entire store, to determine the heat loss capacity rate. The other test concerns only the part of the store, which is heated up (usually the auxiliary heated part). This test is used to determine the degradation of thermal stratification during stand-by. The stand-by period should be such that the losses during this period are approximately half of the stored energy. For these two tests with stand-by periods, the same test should also be performed without a stand-by period.

Flow rates and power values are given as examples only. The chosen flow rate or power should be suited to the type of component, which will be used with those connections.

6.3.2.2 General

This clause describes the thermal test sequences for the different groups of combistores. This clause is based on procedures defined in EN 12977-3, only new items are included. In EN 12977-3 mainly the determination of the thermal capacity, heat loss capacity rate of the entire store and the heat transfer capacity rate of immersed heat exchangers is defined.

The thermal test sequences described in this document shall be carried out for all groups of combistores. The storage device shall be connected to the testing stand according to 6.2.

6.3.2.3 General charge direct (Test CD)

Test CD:

— test phase CD1: conditioning until steady-state is reached;

— test phase CD2: charging through test ports until $\vartheta_{C,o}$ = 55 °C;

— test phase CD3: optional stand-by until approximately half stored energy is lost to ambient;

— test phase CD4: direct discharge of the entire store until steady state is reached.

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Table 2 — Flow rates and store inlet temperatures for Test CD

Test phase	Process	Charge			Discharge		
		$\tilde{\dot{V}}_C$ l/h	$\tilde{\vartheta}_{C,i}$ °C	$\tilde{\vartheta}_{C,o}$ °C	$\tilde{\dot{V}}_D$ l/h	$\tilde{\vartheta}_{D,i}$ °C	$\tilde{\vartheta}_{D,o}$ °C
CD1	conditioning	0	-	-	0,5 × $\dot{V}_n$	20,0	variable
CD2	charge	0,5 × $\dot{V}_n$	60,0	variable	0	-	-
CD3	stand-by	0	-	-	0	-	-
CD4	discharge	0	-	-	0,5 × $\dot{V}_n$	20,0	variable

If the ports are used with a boiler the operating temperature of which is greater than 60 °C (e.g. a wood boiler), a higher inlet temperature ($\vartheta_{C,i}$) may be used.